Apr 16

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

DURING THE SURVEY YEAR

1911-12.

PREPARED UNDER THE DIRECTION OF

COLONEL S. G. BURRARD, C.S.I., R.E., F.R.S.,

SURVEYOR GENERAL OF INDIA.

Printed at the Photo.-Litho. Office, Survey of India,
CALCUTTA,
1913.

Price Two Rupees or Three Shillings.

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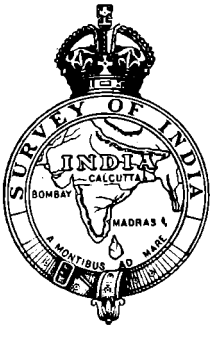

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GENERAL REPORT

SURVEY OF INDIA

1911-12.

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PREFACE.

This report is intended to be general and concise. More detailed descriptions and discussions of results will be found in Volume III of the " Records of the Survey of India, 1911-12."

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12 Index Chart to the Great Trigonometrical Survey.

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1911-1912.

PART I.

ADMINISTRATION.

1. This report deals with the operations of the Survey of India for the year ending 30th September 1912.

2. The Hon'ble Colonel F. B. Longe, C.B., R.E., A.D.C., retired, on the termination of his leave on the 31st October 1911, and Colonel S. G. Burrard, C.S.I., R.E., F.R.S., was confirmed as Surveyor General of India from the same date.

3. Two Imperial Officers Major J. M. Burn, R.E., and Lieutenant H. G. Bell, R.E., died on the 18th March and 26th July 1912, respectively. Mr. T. A. Pope retired from the service on the 11th February 1912, and Mr. John Eccles, M.A., on 8th September 1912.

4. No recruitment was made either for the Imperial or the Provincial Service during the year.

5. The cost of the department for the financial year ending 31st March 1912, was Rs. 32,83,294, against an estimated cost of Rs. 34,56,050.

6. The distribution of the officers in the various offices and parties is shown in the accompanying list.

DISPOSITION OF OFFICERS,

1911-12.

Circle or Branch.	Administrative Officer.	Party or Office.	Locality.	Imperial Officers.	Provincial Officers.	Upper Subordinates.	Lower Subordinate Establishment.	Remarks.
MAP PUBLICATION.	Colonel S. G. Burrard, C.S.I., R.E., F. R. S., *Surveyor General.*	.....	Calcutta ...	.....	.....	.....	.....	
		Surveyor General's Office and Mathematical Instrument Office.	Calcutta ...	Captain F. F. Hunter, I.A., Captain O. H. B. Trenchard, R.E., Lieutenant J. A. Field, R.E.	.....	.....	.....	
		Simla Drawing Office.	Simla ...	Major H. L. Crosthwait, R.E., Captain M. N. MacLeod, R.E.	Messrs. J. P. Barker, A. A. Graham, H.T. Hughes, F. C. Saint.	.....	6 European draftsmen, 24 Indian draftsmen, &c., 4 printers.	
	Major W. M. Coldstream, R.E., *Superintendent, Map Publication.*	Map Publication Office.	Calcutta ...	.....	Mr. M. Gastaud.	.....	....	
		Drawing Office Map Record & Issue Office. Engraving Office.	Calcutta ...	Captain M. O'C. Tandy, R.E.	Messrs. J. O. Greiff, Jagdamba Prasad, P. L. Causley, P. N. Sur, P. Simpson, E. J. H. Hanby, E. B. West, C. C. Byrne, T. W. Babonau, H. C. W. Stotesbury, H. B. Simons, J. R. Newland.	.....	.....	
		Photo.-Litho. Office.	Calcutta ...	Captain A. H. Gwyn, I.A., Lieut. J. A. Field, R.E., Captain C. M. Thompson, I. A.	.....	.....	.....	

Colonel W. J. Bythell, R.E., up to 2nd April 1912, Major C H. D. Ryder, D.S.O., R.E., from 3rd April 1912, *Superintendent, Northern Circle.*	Northern Circle Drawing Office.	Mussoorie ...	Lieut. A. A. Chase, R.E. ...	Messrs. B. R. Hughes, W. Newland, M. C. Petters, E. J. Biggie, E. C. J. Bond, W. H. Strong.	Mr. Husain Buksh, K. S.	48 Clerks, Draftsmen, &c.	Lieut. Chase, R.E., was employed on Special Delhi Survey.
	No. 1 Party ...	Kashmir ...	Major C. H. D. Ryder, D.S.O., R.E., Major F. W. Pirrie, I.A., Lieut. A. A. Chase, R.E., Lieut. K. Mason, R.E.	Messrs. H. H. B. Hanby, E. B. West, D. K. Rennick, R. C. Hanson, W. J. B. Miller.	Messrs. Sher Jang, K. B., Natha Singh, R. S., Lal Singh, R. B., Paras Ram, Janna Prasad.	35 Surveyors, &c.	
	No. 2 Party ...	Punjab ...	Major F. W. Pirrie, I.A., Major E. A. Tandy, R.E.	Messrs. T. W. Babonau, F. B. Powell, J. A. Freeman, W. Newland, E. B. West, Kanak Singh, R. E. Saubolle, E. C. O'Sullivan, J. McCraken, J. A. Calvert.	Mr. Mahindar Singh.	49 Surveyors, &c.	
	No. 3 Party ...	Punjab and U. P.	Capt. A. A. McHarg, R.E., Capt. M. N. MacLeod, R.E., Lieut. A. A. Chase, R.E., Lieut. R. S. Wahab, I.A.	Messrs. B. M. Berrill, A. C. Bose, P. A. T. Kenny, H. C. W. Stotesbury, B. C. Newland, A. J. A. Drake, F. H. Grant, F. J. Grice, J. A. Calvert.	Mr. Muhammad Lutf Ali.	45 Surveyors, &c.	
	No. 4 Party ...	United Provinces	Captain L. C. Thuillier, I.A., Lieut. F. B. Scott, I.A.	Messrs. G. J. S. Rae, H. W. Biggie, C. E. C. French, J. C. C. Lears, A. B. Hunter, G. E. R. Cooper, A. F. Murphy.	Mr. Muhammad Husain Khan.	58 Surveyors, &c.	Includes Establishment of Cantonment Section No. 1.
	Riverain Detachment.	Punjab ...	.....	Messrs. Maya Das Puri, R. S., Moqimuddin.	Mr. Chuni Lal Kapur.	91 Traversers, Computers, &c., 171 Tahsildars, Kānungos, and Patwāris.	

Circle or Branch.	Administrative Officer.	Party or Office.	Locality.	Imperial Officers.	Provincial Officers.	Upper Subordinates.	Lower Subordinate Establishment.	Remarks.
SOUTHERN.	Bt.-Col. T. F. B. Renny-Tailyour, C.S.I., R.E., *Superintendent, Southern Circle.*	Southern Circle Drawing Office.	Bangalore ...	.....	Messrs. A. Ewing, J. O'B. Donaghey, P. R. Anderson, Haji Abdul Rahim, K. S.	Mr. B. V. Narayana Rao.	30 Draftsmen, &c., and 8 pupils.	
		Southern Circle Training Section.	Bangalore ...	.....	Messrs. J. Smith, W. M. Gorman, P. Kennegy.	Messrs. P. S. Vengusvami, G. Hanumanta Rao.	1 Surveyor, & 9 pupils.	
		No. 5 Party ...	Central Provinces & Central India.	Major C. L. Robertson, C.M.G., R.E., Lieut. K. W. Pye, R.E., Lieut. C. G. Lewis, R.E., Lieut. C. F. Nation, R.E.	Messrs. F. P. Walsh, J. H. S. Wilson, S. S. McA'Fee Fielding, P. Kennegy, C. West, Munshi Lal, F. C. Pilcher, C. O. Picard.	Messrs. Eknath Battu, Ram Narayan Hastir.	31 Surveyors, &c., and 2 pupils.	
		No. 6 Party ...	Berār and Hyderābād.	Major H. Wood, R.E., Lieut. K. W. Pye, R.E., Lieut. C. F. Nation, R.E.	Messrs. J. H. S. Wilson, E. A. Meyer, F. B. Kitchen, R. B. Gildea, J. O'C. Fitzpatrick, A. J. Moore, A. V. Dickson.	Mr. Dharmu ...	26 Surveyors, &c., and 5 pupils.	
		No. 7 Party ...	Madras, Mysore, & Coorg.	Captain C. P. Gunter, R.E., Lieut. J. D. Campbell, R.E.	Messrs. W. M. Gorman, J. O'B. Donaghey, P. R. Anderson, H. D. W. Stotesbury, H. H. P. Butterfield, J. C. St. C. Pollett.	Messrs. Abdul Hakk, K.S., K. Mandanna.	23 Surveyors, &c., and 5 pupils.	
		No. 8 Party ...	Madras ...	Captain C. M. Browne, D.S.O., R.E., Captain R. Foster, I.A.	Messrs. R. Waller-Senior, W. F. E. Adams, E. J. Biggie, S. F. Norman, J. H. Williams, M. Mahadeva Mudaliar, Balaji Dhondiba, M. S. Ganesa Aiyar.	Mr. Anantarao Dhondiba, R.S.	26 Surveyors, &c., and 7 pupils.	
EASTERN.	Bt.-Col. G. B. Hodgson, I.A., *Superintendent, Eastern Circle.*	Eastern Circle Drawing Office.	Shillong, Assam.	.....	Messrs. P. J. Barrington & E. Claudius.	.....	33 Clerks, draftsmen, &c.	
		No. 9 Party ...	Bihār & Orissa.	Major G. A. Beazeley, R.E., Captain R. H. Phillimore, R.E., Lieut. P. G. Huddleston, R.E.	Messrs. Dhani Ram, B. C. Newland, A. K. Mitra, W. P. Hales, F. Byrne, D. N. Banerjee.	Messrs. Dalbir Rai, M. R. Mazumdar, R. D. Thaplyal.	37 Surveyors, &c., 5 Soldier Surveyors under training.	
		No. 10 Party ...	Upper Burma ...	Bt.-Major E. T. Rich, R.E., Lieut. W. E. Perry, R.E.	Messrs. O. D. Smart, P. Williams, W. G. Jarbo, V. W. Morton, Asmat-Ullah Khan, K.S., C.B. Sexton, W. H. Strong.	Messrs. Hayat Muhammad, K.S., B. C. H. Collins.	27 Surveyors, &c., 2 pupils, 1 Soldier Surveyor under training.	

J. Eccles, Esq., M.A., till 8th September, Major H. L. Crosthwait, R.E., from 9th to 22nd September, Lieut.-Colonel G. P. Lenox-Conyngham, R.E., from 23rd September, *Superintendent of the Trigonometrical Survey.*	No. 11 Party ...	Karenni and Lower Burma.	Major E. A. Tandy, R.E., Captain L. G. Crosthwait, I.A.	Messrs. C. Litchfield, A. M. Talati, T. P. Dewar, H. St. J. Kenny, A. J. Booth, R. M. Wyatt.	Mr. Lachman Daji Jadu, R. B.	25 Surveyors, &c., 2 pupils.
	No. 12 Party ...	Assam ...	Capt. R. H. Phillimore, R.E., Lieut. G. F. T. Oakes, R.E.	Messrs. W. Skilling, Pramadaranjan Ray, E. M. Kenny, Amjad Ali, L. Williams, P. C. Mitra, H. H. Creed.	Mr. Nanak Chand Puri.	37 Surveyors, &c., 2 Soldier Surveyors.
	Trigonometrical Survey Office.	Dehra Dūn ...	J. de Graaff Hunter, Esq., M. A., Lt. H. T. Morshead, R.E.	Messrs. Syed Aulad Hossein, K. B., O. C. Ollenbach, H. A. Charrier, Duni Chand Puri, N. S. Harihara Iyer.	Messrs. Ram Singh, R. S., Sarat Kumar Mukerji.	.....
	No. 13 Party ...	U. P. & Bengal	Major H. L. Crosthwait, R.E.	.....	Mr. Bidhu Bhusan Shome.	2 Computers, &c.
	No. 14 Party ...	U. P. & Bengal	Capt. H. J. Couchman, R.E.	Mr. Hanuman Prasād ...	.....	4 Computers, &c.
	No. 15 Party ...	Madras, Kashmir, Bengal, Bombay, & C. P.	Major H. H. Turner, R.E., Capt. H. McC. Cowie, R.E., Lieut. F. J. M. King, R.E., Lieut. H. G. Bell, R.E., Lieut. E. B. Cardew, R.E.	Messrs. C. H. Tresham, Abdul Hai, V. D. B. Collins, F. W. Smith, G. A. Norman, B. T. Wyatt, Abdul Karim, K. S. Gopalachari, V. P. Wainright, C. S. McInnes.	Mr. Jugal Behari Lal.	25 Computers, &c.
	No. 16 Party ...	Indian Ports ...	Major J. M. Burn, R.E. ...	Messrs. H. G. Shaw, Syed Zille Hasnain.	.....	21 Computers, &c.
	No. 17 Party ...	Burma, Punjab, and Assam.	Lieut.-Colonel G. P. Lenox-Conyngham, R.E., Lieut. E. B. Cardew, R.E., Capt. V. R. Cotter, I.A.	Messrs. Syed Zille Hasnain, A. M. Talati, O. N. Pushong, D. H. Luxa, T. F. Kitchen, O. D. Jackson, Jiya Lal, N. N. Chuckerbutty.	Mr. Karuna Kumar Das.	12 Computers, &c.
	No. 18 Party ...	India & Burma.	Capt. R. H. Thomas, R.E.	Messrs. H. P. D. Morton, Rama Prasad Ray, N. R. Mazumdar, Raj Bahadur Mathur.	.....	19 Computers, &c.
	Forest Map Office.	Dehra Dūn ...	Major J. M. Burn, R.E., Lieut. H. G. Bell, R.E., Lieut. F. J. M. King, R.E.	Mr. J. H. Nichol ...	.....	.....

PART II.

SURVEY WORK IN THE FIELD.

I.—TOPOGRAPHICAL SURVEYS.

NORTHERN CIRCLE (*vide* index map No. 1).

7. *No. 1 Party.*—This party with its Headquarters at Srinagar continued work in the Kashmīr State and surveyed an area of 4,489 square miles on the 1 inch = 1 mile scale in the Kashmīr proper and Kishenganga valleys. Field operations were started in April and brought to a close by the middle of October 1912. The winter of 1911-12, though mild, was a late one, and the snow in the higher hills of the Kashmīr valley made work very difficult in April and May, and in the Kishenganga valley it was impossible to do any thing before June. For these reasons the strength of the party had to be increased by transfer of hands from other parties to complete the season's programme in time.

8. *No. 2 Party.*—No. 2 Party surveyed an area of 7,369 square miles in Amritsar, Sialkot, Gujrānwāla, Lahore, Ferozepore, Jullundur, Hoshiārpur and Gurdāspur districts and Kapurthala State in the Punjab. About three-quarters of this was revision of previous 1-inch maps and the remainder new survey. The country was flat and open plains except for a small bit of Siwālik hills in the North-East.

9. *No. 3 Party.*—No. 3 Party completed a revision survey of an area of 6,187 square miles on the 1-inch scale in Moradābād, Budaon, Bareilly, Hardoi, Etah and Farrukhābād districts and a small portion of Rāmpur State in the United Provinces. The country surveyed was flat and well cultivated with a few sandy knolls in the tract between the Ganges and the Rāmganga rivers. Though the country cannot be called well wooded, there are numerous mango groves and all the main roads have avenues of trees.

10. *No. 4 Party.*—No. 4 Party continued work in the United Provinces and surveyed an area of 5,807 square miles in the districts of Sitapur, Hardoi, Lucknow, Barabanki, Kheri and Bahraich, the work in the two latter districts being only a supplementary survey. The country surveyed was a flat plain, generally well cultivated and interspersed with an abundance of groves. On the east of the work, however, along the Gogra River and its tributaries, occurred a broad tract of country lying at a lower level than the surrounding plain and cut up by innumerable streams and back waters. A traverse section of this party ran traverses to supplement old work where necessary. The Cantonment Section of this party was employed on the survey of the Quetta Cantonment and Civil station on the scale of 16 inches = 1 mile. The area of the former is about 17 square miles, and that of the latter, 1,100 acres. In addition to these, the Cantonment section is also surveying the Quetta Fort on the scale of 50 feet = 1 inch, (area about 53 acres), and a tract of waste land, (some 700 acres), lying N. W. of cantonment limits for the extension of ranges. The whole of the field work is nearing completion and should be finished by December next. The fair drawing of these maps is being carried on at the same time as field work. Proofs of 5 cantonments, *viz.*, Allahābād, Hyderābād, Risālpur, Loralai and Fort Sandeman, were received for colouring during the year.

11. *The Punjab Riverain Detachment.*—This detachment continued the work of traversing and laying down base lines. 332·95 linear miles of main traverse and 1,911·26 linear miles of minor traverse were run, and 8,541 theodolite stations were fixed along the banks of the rivers Sutlej, Ravi, Chenāb and Jhelum, in districts Hoshiārpur, Ambāla, Ferozepore, Lahore, Montgomery, Sialkot, Gujrāt, Shāhpur and Jhelum. 492 corners of 164 squares were marked with permanent mark-stones on both banks of the Sutlej and the

Jhelum rivers, to serve as bases for the future demarcation of boundaries in the bed of these rivers. 1,997 plotted and 485 boundary "*masāvis*" were completed and 30 4-inch sheets were traced and supplied in time to the Settlement officers of Hoshiārpur, Una, Ferozepore, Sialkot and Shāhpur. Besides these, 129 miscellaneous traces were prepared, and all the traverse stations laid out during the season were plotted on 28 4-inch sheets.

12. In addition to the above, 20 4-inch riverain boundary sheets were plotted and compiled, 10 sheets typed, 23 sheets finally completed, and 371 village maps were reduced by pantagraph to the scale of 4 inches=1 mile.

13. The detachment also carried out the 25-acre rectangular survey in continuation of the last year's work in the remaining tract commanded by th Lower Bāri Doāb Canal. In all, fifty five thousand 25-acre rectangles were broken. Nearly 40 per cent. of the work was tested by the tahsildars, naib tahsildars and the Survey officers and 15 per cent. was checked with the theodolite traverse. 4,782 linear miles of traverse were run and 13,788 theodolite stations fixed and it is hoped that the whole of this demarcation work will be finished by December 1912.

14. *The Delhi Survey Detachment.*—In connection with the transfer of the capital of India from Calcutta to Delhi, a Town-planning Committee was appointed at Delhi by the Government of India, and to meet the requirements of that Committee, orders were received from Government in March 1912, for a 4-inch revision survey of Delhi and vicinity, with contours at 5ft. vertical intervals, as the existing maps were not considered sufficient. This urgent and special work was carried out by a detachment from the Northern Circle under the immediate supervision of Lieutenant A. A. Chase, R.E., to whom 3 Provincial officers and 18 surveyors were temporarily lent from Nos. 2, 3, & 4 Parties to do the work. The revision of the map in the field was completed on 25th April 1912, and the contouring by 5th May, and 30 copies of the map in black and brown, reproduced by the Vandyke process, were supplied to the Committee on the 13th May 1912. The map was subsequently fair drawn in No. 3 Party, and was completed by the 15th August 1912.

SOUTHERN CIRCLE (*vide* index map No. 2).

15. *No. 5 Party.*—No. 5 Party surveyed an area of 3,473 square miles in the Jubbulpore, Narsinghpur, Hoshangābād, Chhindwāra and Betūl districts of the Central Provinces and in the Bhopal and Gwalior States of Central India, and triangulated an area of 2,493 square miles in the Nāgpur, Bhandāra, Chhindwāra and Seonī districts of the Central Provinces. The nature of the country surveyed varied from the steep and wooded hills lying north and south of the valley of the Narbada River to the flat and undulating cultivated land in that valley.

16. *No. 6 Party.*—No. 6 Party surveyed an area of 1,745 square miles in the Akola and Yeotmāl districts of Berār, and in the Adilābād, Nānder and Parbhani districts of Hyderābād, triangulated an area of 2,800 square miles in the Akola and Buldāna districts of Berār and in the Aurangābād, and Parbhani districts of Hyderābād, and traversed 707 linear miles of boundaries of reserved forests in the Akola, Buldāna and Yeotmāl districts of Berār. It also surveyed the Cantonment of Santa Cruz. The country surveyed was of a varied nature, the larger portion being fairly open; rather more than one-third, however, was covered with forest growth, and, as this was combined with intricate ground, progress was necessarily slow.

17. *No. 7 Party.*—No. 7 Party surveyed an area of 2,347 square miles in the South Kanara and Malabar districts of Madras, in Mysore and in Coorg, and triangulated 2,321 square miles in the Salem and North Arcot districts of Madras and in Mysore. The country varied from the low lying intricate undulating country of the west coast, consisting of cultivated valleys fringed with dense groves of palms, to the bold crests of the jungle-covered Western Ghats and the undulating plateau of Mysore to the east.

18. *No. 8 Party.*—No. 8 Party surveyed an area of 1,550 square miles in the Malabar and Coimbatore districts and in the Cochin and Travancore States of Madras, and traversed 182 linear miles in the Travancore State of Madras. The country surveyed in the plains consisted of paddy fields surrounded by dense groves of palms, and, in the hills, consisted of forest which generally became denser as the elevation increased. In some cases, however, the hill tops were grassy, but, as the grass was generally very thick and high, from a surveying point of view, it was equivalent to dense forest. Survey work was slow, laborious and expensive.

EASTERN CIRCLE (*vide* index map No. 3).

19. *No. 9 Party.*—No. 9 Party was transferred to the Eastern Circle, after the close of the field season 1910-11. It surveyed an area of 2,592 square miles, on the 1-inch scale, in the Singhbhūm, Ranchi and Manbhūm districts and Orissa Feudatory States of the Bihār and Orissa Province, and 4 square miles of forests on the 2-inch scale. A small amount of traversing of forest boundaries, (164 linear miles), was also carried out. The country surveyed was for the most part hilly and wooded.

20. *No. 10 Party.*—No. 10 Party surveyed an area of 2,760 square miles in the Kathā, Myitkyinā and Bhāmo districts and in Möngmit State of Upper Burma, including 71 square miles of country beyond the Burma-China frontier which were sketched. 2,836 square miles were triangulated and traversed in the Myitkyinā district and 192 linear miles of forest boundary surveys were completed.

The country lay in the valley of the Irrawaddy between Kathā and Myitkyinā, (omitting the portion near Bhāmo which was surveyed in 1910-11), and extended eastwards through the Kachīn hills to the Chinese frontier. It was partly flat and partly hilly, but everywhere covered with dense jungle.

The section employed in giving practical training in cadastral surveying to officers of the Burma Land Records Department continued to be attached to this party until the 1st April 1912, when it was transferred to that department. Officers of several years' standing as well as probationers were sent for instruction, and the former were also instructed in the rudiments of topographical surveying, but, as they were only allowed 2 months for this part of the course, they cannot be expected to have derived much benefit from it.

One Officer, one Upper Subordinate and two surveyors were attached to political missions during the field season in North Burma.

21. *No. 11 Party.*—No. 11 Party surveyed a total area of 2,638 square miles of which 1,800 square miles were 1-inch, 117 square miles 2-inch, 1,628 square miles $\frac{1}{4}$-inch survey and 93 square miles 1-inch revision survey.

Work lay in Karenni and the Southern Shān States to the north, where the ground was mostly steep, rough and rocky and was surveyed on the 1-inch scale, and in the Salween, Thaton, and Toungoo districts, which consisted of jungle-clad hills which were surveyed on the $\frac{1}{4}$-inch scale.

Triangulation was completed over an area of 3,950 square miles for 1-inch survey in the Amherst and Tavoy districts of Tenasserim, and of 530 square miles in the Salween district for the $\frac{1}{4}$-inch survey which was also carried out this season.

22. *No. 12 Party.*—No. 12 Party surveyed an area of 3,359 square miles in the Khāsi and Jaintia Hills, and Kāmrūp districts, and carried out triangulation and traversing, preparatory to next season's detail survey, over an area of 3,250 square miles in the Kāmrūp, Darrang and Nowgong districts. The above survey was on the 1-inch scale with the exception of 77 square miles of reserved forest surveyed on the 2-inch scale. The country under survey consisted largely of densely wooded hills, open towards the highest parts, but mostly of the alluvial plains of the Brahmapūtra valley, thickly populated for the most part but elsewhere consisting of swamps and large sheets of shallow water known locally as 'bils'.

TOPOGRAPHICAL SURVEYS.

Table showing Out-turns and Costs.

1911-1912.

1	2	3	4	5	6	7	8	9	10	11	12	13
Circle.	Party.	Locality.	Character of Ground.	Type of Survey.	Scale.	Out-turns.		Total Out-turn of Survey on all scales.	Difference from 6,000 square miles per party. (*a*)	Total cost.	Cost-rate per square mile. Survey and Mapping.	Remarks.
						Survey.	Mapping.					
						Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Rs.*	*Rs.*	
N.	No. 1	Kashmir State ...	Hilly and mountainous ...	Survey ...	1-inch	4,489	4,489(*b*)	4,489	—1,511	1,36,287	30·4	(*b*) Mapping incomplete.
N.	No. 2	Punjab ...	Flat and open plains except a small bit of hill in the north-east.	Survey and Revision Survey.	1-inch & 1½-inch	7,369	7,369	7,369	+1,369	1,06,116(*c*)	14·4	(*c*) Excluding Rs. 4,718 on Delhi special survey.
N.	No. 3	United Provinces ...	Flat alluvial plains ...	Revision Survey	1-inch	6,187	6,187	6,187	+187	85,063(*d*)	13·7	(*d*) Excluding Rs. 4,166 on Delhi special survey.
N.	No. 4	United Provinces ...	Plains ...	Survey and Supplementary Survey.	1-inch	5,807	5,807	5,807	—193	1,01,163(*e*)	17·4	(*e*) Excluding Rs. 2,240 and Rs. 20,737 on Quetta Cantonment and Civil Line Survey.
			Totals, Northern Circle ...	.....	...	.....	23,852	23,852	—148	4,28,629	17·97	
S.	No. 5	Central Provinces and Central India.	Varied, chiefly wooded hills.	Survey ..	1-inch	2,569	2,750	3,473	—2,527	1,04,806	30·2	
			Open cultivated plains ...	Revision Survey	1-inch	904						
S	No. 6	Berār and Hyderābād.	Varied ...	Survey ...	1-inch	1,337	1,400	1,745	—4,255	98,521	56·5	
			Intricate forests ...	Survey ...	2-inch	408						
S.	No. 7	Madras, Mysore, and Coorg.	High hills, mostly forest-clad.	Survey ...	1-inch	562	2,258	2,347	—3,653	83,359	35·5	
			Low undulating, very intricate.	Survey ...	1½-inch	1,059						
			Heavy jungle-clad hills ...	Survey ...	2-inch	182						
			High forest-clad hills ...	Revision Survey	1-inch	425						
			Low undulating, very intricate.	Revision Survey	1½-inch	119						

S.	No. 8	Madras ...	Partly flat enclosed, partly wooded hills.	Survey ...	1-inch	1,202	1,447	1,550	—4,450	1,22,780	79·2	
			Flat enclosed ...	Survey ...	1½-inch	282						
			Hilly dense forests ...	Survey ...	2-inch	66						
			Totals, Southern Circle ...	.....	.....	....	7,855	9,115	—14,885	4,09,466	44·92	
E.	No. 9	Singhbūm district of Chhota Nāgpur and Orissa Feudatory States.	Mostly hilly and thickly wooded.	Resurvey, Revision Survey and Supplementary Survey.	1-inch & 2-inch	2,592 4	2,199	2,596	—3,404	1,01,971(*f*)	39·2	(*f*) Excludes Rs. 14,587 for traversing of Forest boundaries and Rs. 6,818 for Punjab mapping.
E.	No. 10	Upper Burma, Kathā, Bhāmo, and Myitkyinā districts.	All densely wooded; partly hilly and partly flat.	Survey ...	1-inch	2,194	2,990	2,689(*h*)	—3,311	1,36,774(*i*)	50·9	(*g*) Trans-border sketched.
				Revision Survey	1-inch	280						(*h*) Excluding reconnaissance survey.
				Reconnaissance Survey.	1-inch	71(*g*)						(*i*) Excludes Rs. 25,722 expended on exploration surveys, forest boundary surveys and training of officers of Burma Land Records Department. Cost high owing to large area of 2-inch survey.
				Survey ...	2-inch	215						
E.	No. 11	Karenni and Salween, Taungoo and Thaton districts, Lower Burma.	Steep, rocky hills, lightly wooded in Karenni elsewhere low jungle-clad hills.	Survey ...	1-inch	1,800	3638	3,638	—2,362	1,38,176	37·9	
				Survey ...	2-inch	117						
				Survey ...	¼-inch	1,628						
				Revision Survey	1-inch	93						
E.	No. 12	Khāsi and Jaintia Hills and Kāmrūp districts of Assam.	Partly open and flat and partly wooded and hilly.	Survey ...	1-inch	1,566	3,359	3,359	—2,641	1,30,097(*j*)	38·7	(*j*) Includes cost of forest boundary traversing not recorded separately.
				Revision Survey	1-inch	178						
				Supplementary Survey.	1-inch	1,538						
				Survey ...	2-inch	77						
			Totals, Eastern Circle ...	.....	..	.....	12,186	12,282	—11,718	5,07,018	41·28	
			GRAND TOTALS ...	.....	...	.....	43,893	45,249	—26,751	13,45,113	29·73	

(*a*) The figure 6,000 (square miles) from which differences are shown in column 10 is the full out-turn per party which it is hoped to attain in the future.

Table shewing progress of Topographical Surveys, 1905 to 1912.

Survey year.	Scale.	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-06	1-inch and 2-inch	5,995	1,660	10,322	17,977
1906-07	do.	7,277	7,666	8,659	23,602
1907-08	do.	14,530	9,256	12,431	36,217
1908-09	do.	17,957	12,526	11,542	42,025
1909-10	do.	23,833	12,532	9,736	46,101
1910-11	do. and 1½-inch	27,528	13,171	9,218	49,917
1911-12	do.	23,852	9,115	12,282	45,249
Areas completed to date	.....	120,972	65,926	74,190	261,088
Total areas included in topographical programme.	Total of 1-inch & ½-inch work allotted.	750,000	542,800	528,800	1,821,600
Approximate areas remaining for Survey	Total of 1-inch & ½-inch work still remaining.	629,028	476,874	454,610	1,560,512

NOTE 1.—As was suggested in the note on page 12 of the General Report of the Survey of India for 1910-11, the question of reducing the scale of survey in certain regions has now been considered, and the half-inch scale has been accepted for a larger area than was contemplated in the original topographical programme. The exact figures showing the areas allotted to 1-inch and ½-inch surveys, respectively, are not to hand as yet, and only the total figures for both scales can be shewn.

The reasons for this reduction of the scale of survey are as follows:—(1) to enable the completion of the survey programme to be carried out by 1935 if possible, (2) to reduce the expenses of survey in hilly, desert or other depopulated regions, where the one-inch scale for maps seems at present unnecessary.

NOTE 2.—The figures showing the total areas included in the topographical programme of the circles and the areas remaining for survey are liable to future correction, (1) because the limits of the several circles have not been everywhere settled, (2) because in some small areas surveys are not found up to standard and require revision. These areas get unavoidably included both in the totals for the year of actual survey and in the totals for the year in which the revisionary survey takes place, and the figures thus become slightly incorrect.

NOTE 3.—The small survey out-turn this year is due to the special surveys on which the department was engaged, *viz.*, the Berar and Travancore Forest Surveys, in both of which, owing to the dense jungle, progress was necessarily slow, also to the fact that 9 Imperial Officers were employed on the Abor Expedition, Mishmi, Miri and Hkamti Long Mission Surveys on the North-East Frontier and in North Burma.

II.—FOREST SURVEYS.

23. The forest surveys of the year were carried out in every case by the topographical parties in whose spheres of operations the forests lay. The surveys were for the most part on the 2-inch scale; but some were on the 1-inch scale, and forest boundary surveys on the 4-inch scale were carried out over a considerable area. The revision of certain areas previously surveyed on the 4-inch scale by the old Forest Survey Branch was also effected.

Northern Circle.

24. *Punjab.*—No. 2 Party surveyed an area of 96·89 square miles of forests including reserved and unclassified forests and rakhs, in the Lahore and Amritsar districts in connection with the ordinary topographical survey on the scale of 1 inch = 1 mile. Of this area 64 square miles had been previously surveyed on the 4-inch scale by the old Forest Survey Branch.

25. *United Provinces.*—No original forest surveys were done, but No. 4 Party surveyed an area of 9·54 square miles of the Motipur block in the Bahraich district on the scale of 1 inch = 1 mile in the course of the ordinary topographical work which had been previously surveyed on the 4-inch scale by the old Forest Survey Branch.

Southern Circle.

26. *Central Provinces.* (*Berār Circle*).—No. 6 Party continued the topographical survey of Berār and Hyderābād during the year under review, and all A and B class forests and selected C class forest, falling in the area under survey and in 5 of the sheets that will be surveyed next year, were surveyed on the 2-inch scale and their boundaries rigorously traversed by theodolite and plotted on the 4-inch scale. All the forests surveyed are situated in the Yeotmāl district and, with the exception of the eastern two-thirds of the Kinwat reserve, the survey of all the forests in this district has now been completed. The area surveyed on the 2-inch scale amounted to 310 square miles and the boundary traversing to 526 linear miles. In addition about 181 linear miles of the boundaries of the A, B, and C class forests lying in the area proposed for detail survey next season in the Akola and Buldāna districts, were traversed in advance.

27. *Coorg.*—In the course of its ordinary operations, No. 7 Party surveyed on the 2-inch scale the Padinalknad Ghat and the Patti Ghat forest reserves in Coorg. They embrace nearly the whole of the western slope of the Western Ghats up to the South Kanara and Malabar boundary on the west and the Malabar district on the south. The area thus surveyed amounted to 73 square miles. In addition to these, the survey of all Jammamalle boundaries, omitted from the work carried out in season 1909-10, was executed, together with the survey of the new realignment of the Brahmagiri forest reserve, thereby satisfying the wants of the Coorg forest authorities and completing the whole of the forest reserves in Coorg. No new theodolite boundary traverse was executed but the Madras Revenue Survey traverse was utilised as far as it coincided with the forest boundaries.

28. *Madras Presidency.*—In the South Kanara district, 26 reserved forests including all extensions of less than one square mile in area, were surveyed by No. 7 Party on the 2-inch scale, thus completing the survey of all the reserved forests in this district up to date. The total area surveyed amounted to 77 square miles.

In the South Coimbatore division, the portion of the Anamalai forest falling in sheet 58 $\frac{B}{16}$, area $8\frac{1}{2}$ square miles, was resurveyed on the 2-inch scale, by No. 8 Party, as the old 4-inch maps were found to be extremely inaccurate.

Eastern Circle.

29. *Bihār and Orissa.*—The detail survey of only 4 square miles of forests was done this season and 164 linear miles of boundaries were traversed in the Singhbhum and Chaibassa divisions. The whole area for detail survey on the 2-inch scale is 53 square miles of which 26 square miles will be done next season.

30. *Upper Burma (Northern Circle).*—Detail survey on the 2-inch scale was carried out of the Shwegu extension, Wapyudaung, Uyahathā reserves and part of the Nammi reserve of the Bhāmo and Myitkyina divisions, 215 square miles. Their boundaries were also traversed with the theodolite and also the boundaries of the Loimaw, Mohnyin, N. E. extension, Nanhim, E. extension, Mawhun and Zigyun reserves, and part of the Nansonti reserve of the Kathā and Myitkyina divisions, 192 linear miles. These latter reserves will not be surveyed in detail next season, as the *locale* of operations has been shifted to the northward.

31. *Southern Shān States.*—The detail survey of the Tamhpak reserve, 64 square miles, was carried out.

32. *West Salween Division.*—The Dagwīn and Lower Dagwīn reserves, 53 square miles, were surveyed on the 2-inch scale.

33. *Assam.*—An area of 77 square miles of the North Kāmrūp Game Reserve situated in the Kāmrūp division was surveyed on the 2-inch scale.

This area lies on the plains at the foot of the Bhutan hills and consists of dense *khagra* grass and tree jungle.

III.—TRIGONOMETRICAL SURVEYS.

GEODETIC SURVEY.

(a).—Astronomical Latitudes.

34. *No. 13 Party.*—No. 13 Party was employed on latitude observations, the new Zenith Telescope by Messrs. T. Cooke & Sons being used for the first time. 10 stations in Bihār and Orissa were occupied, extending north from the line Ranchi-Lohardaga to Muzaffarpur. One station, Khajnaur, in the Siwāliks was also visited. The results of the observations are given in the following table :—

Station.	Height.	Longitude.	Geodetic latitude.	Astronomical latitude.	A—G.
	Ft.	° ′	° ′ ″	″	
Bulbul	3,352	84 26	23 37 44·63	53·44±0·065	+8·81
Teona	740	84 10	24 34 38·94	49·76±0·061	+10·82
Mednipur	335	84 22	25 5 14·02	22·35±0·061	+8·33
Nuaon	251	84 14	25 34 37·94	45·64±0·059	+7·70
Jalāljur	232	84 23	26 3 39·42	45·56±0·043	+6·14
Mahwāri	3,153	84 54	23 26 4·96	9·28±0·051	+4·32
Mahār	1,606	85 10	24 44 20·88	31·12±0·054	+10·24
Bihār	391	85 31	25 12 26·05	39·27±0·048	+13·22
Dubauli	189	85 20	25 40 16·23	22·99±0·052	+6·76
Pahlādpur	175	85 27	26 4 21·01	27·24±0·047	+6·23
Khajnaur	2,576	77 53	30 16 23·63	56·70±0·087	—26·93

A positive value of (A — G) denotes a southerly attraction of the plumb-line.

35. The deflection at Bihār is the largest southerly deflection as yet found in India, that at Teona being the second largest. The decrease in deflection between Teona and Bulbul and between Mahār and Mahwāri indicates an excess of gravity between these stations and makes it probable that the "hidden chain" of high density has been crossed in passing from one to the other.

(b).—Pendulum Operations.

36. *No. 14 Party.*—No. 14 Party made pendulum observations over the same area as that covered by the latitude operations, only one observer being available for this and No. 13 Party.

The table annexed gives the results of the observations. The large negative values at the northern stations should be noted, these being greater than have been hitherto found in similar localities.

The observations at Sultānpur were made in 1910 but have not hitherto been published.

The investigation into the theory of isostatic compensation has been continued and some results are published in the Records of the Survey of India, Vol. III.

Captain Couchman has suggested that Colonel Burrard's hypothesis, (that the Indo-Gangetic alluvium is covering a crack in the sub-crust of the Earth), should be regarded as supplementary to Hayford's theory of isostasy and not as antagonistic to the latter.

SUMMARY OF RESULTS.

Stations.	Latitude.	Longitude.	Height above M. S. L.	Observed value of g.	Correction for Height.	Correction for Mass.	Correction for Terrain.	$g_0 = g$ corrected for Height.	$g_0' = g$ corrected for Height, Mass and Terrain.	γ_0	$g_0 - \gamma_0$	$g_0'' - \gamma_0$
	° ′ ″	° ′	*Feet.*	*Dynes.*	*Dynes.*	*Dynes.*	*cm.*	*Dynes.*	*Dynes.*	*Dynes.*	*Dynes.*	*Dynes.*
Japla	24 31 58	84 0	474	978·856	+0·044	−0·017	0	978·900	978·883	978·895	+0·005	−0·012
Daltonganj	24 2 5	84 4	707	978·827	+0·066	−0·025	0	978·893	978·868	978·861	+0·032	+0·007
Ranchi	23 23 5	85 19	2,167	978·691	+0·202	−0·076	0	978·993	978·817	978·818	+0·075	−0·001
Gaya	24 47 42	85 0	361	978·884	+0·034	−0·013	0	978·918	978·905	978·913	+0·005	−0·008
Monghyr	25 22 53	86 28	154	978·909	+0·014	−0·005	0	978·923	978·918	978·954	−0·031	−0·036
Arrah	25 34 10	84 39	188	978·918	+0·018	−0·007	0	978·936	978·929	978·967	−0·031	−0·038
Sasaram	24 57 21	83 59	340	978·903	+0·032	−0·012	0	978·935	978·923	978·925	+0·010	−0·002
Moghalsarai	25 17 3	83 6	257	978·919	+0·024	−0·009	0	978·943	978·934	978·947	−0·004	−0·013
Buxar	25 34 42	83 59	207	978·933	+0·019	−0·007	0	978·952	978·945	978·968	−0·016	−0·023
Muzaffarpur	26 7 5	85 25	179	978·934	+0·017	−0·006	0	978·951	978·945	979·006	−0·055	−0·061
Majhauli Rāj	26 17 46	83 58	219	978·928	+0·020	−0·008	0	978·948	978·940	979·019	−0·071	−0·079
Gorakhpur	26 44 58	83 23	257	978·936	+0·024	−0·009	0	978·960	978·951	979·052	−0·092	−0·101
Sultānpur	26 16 6	82 5	314	978·959	+0·029	−0·011	0	978·988	978·977	979·017	−0·029	−0·040

TRIANGULATION, (*vide* Index Map No. 12).

37.—During the year under report No. 15 Party carried out Principal and Secondary Triangulation.

(a).—Principal Triangulation.

(i).—The Sambalpur Series was commenced. This meridional series emanates from the side Bhursu, (XLIX)—Harihārpur, (L), of the Calcutta Longitudinal Series in Latitude 23°, Longitude 85°, and at first trending to the south-west till it lies astride the meridian of 84°, afterwards extends southwards with a view to junction with the East Coast Series at Latitude 19°, Longitude 84°. During the season the series was carried as far as Latitude 22°.

(b).—Secondary Triangulation.

(ii).—The Bhīr Series was completed between the Khanpisūra and the Great Arc Principal Series. It lies along the parallel of 19°.

(iii)—The Ranchi Series in Latitude 23° was completed between the South Parasnāth in Longitude 85° and the New Sambalpur Principal Series in Longitude 84°.

(iv).—The Villupurām Series running through the districts of S. Arcot and Salem in Latitude 12°, and connecting the Great Arc and the South East Coast Series was completed.

(v).—The Madura Series. This Series, of which only the building of stations has so far been accomplished, lies along the parallel of 10°, between the Great Arc and the South East Coast Series.

(vi).—Bombay City Triangulation. A network of triangulation to serve as the frame on which to construct a large scale survey of the city and island, based on a side of the Bombay Longitudinal Series has been commenced.

(vii).—Kashmīr Secondary Operations. Triangulation has been carried from the northern end of the Kashmīr Principal Series in the neighbourhood of Gilgit along the Hunza and Kanjut valleys with the object of forming a connection with the Russian Triangulation near the Beyik pass in the Taghdumbash Pamīr.

The table below gives details regarding the observational work on the different series :—

SUMMARY OF PARTICULARS.

	Sambal-pur.	Ranchi.	Bhir.	Villu-puram.	Kashmir Secondary Trian-gulation.	Madura.	Bombay.
No. of Stations observed at	15	13	26	20	9	...	54
,, ,, newly fixed	13	11	22	16	8	...	...
,, ,, built	17	11	35	16	21	6	125
Length of triangulation completed in miles.	112	100	176	99	40	...	...
,, ,, still remaining to be done	180	...	80	...	110	...	...
Area of triangulation in sq. miles ...	2,570	988	2,764	1,106	...	...	75
Theodolite used	T. & S. 12-inch V	8-inch Micro.	8-inch Micro.	8-inch Micro.	6-inch Micro.	...	8-inch Micro.
Number of triangles observed ...	21	13	24	18	7	6	...
,, astronomical azimuths observed.	1	...	...	...	..	...	...
Maximum triangular error	1″·526	6″·34	3″·72	4″·05	...	...	6″
Average triangular error	0″·473	2″·17	0″·93	1″·77	...	...	2″·56
Mean closing error in Lat.	...	0″·03	0″·18	0″·06	...	...	...
,, ,, ,, Long.	...	0″·03	0″·15	0″·06	...	...	...
,, ,, ,, height	...	22 feet	14 feet	6 feet	...	...	...
,, ,, ,, azimuth	...	1″·4	1″·27	3″·73	...	...	...
,, ,, ,, log side, the unit being the seventh decimal place	...	124	180	38	...	...	...

TIDAL OPERATIONS.

38. *No. 16 Party.*—Observations were taken by means of self-registering tide-gauges during the year, at the stations enumerated in the following list :—

	Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1	Aden	1879 ...	Still working	33	
2	Karāchi ...	1868 ...	1880	*13 } 45	* Small tide-gauge working.
		1881 ...	Still working	32 }	
3	Bombay, (Apollo Bandar) ...	1878 ...	,,	34	
4	Bombay, (Prince's Dock) ...	1888 ...	,,	24	
5	Madras ...	1880 ...	1890	10 } 27	
		Restarted 1895	Still working	17 }	
6	Kidderpore	1881 ...	,,	31	
7	Rangoon	1880 ...	,,	32	
8	Port Blair	1880 ...	,,	32	
9	Moulmein ...	1880 ...	1886	6 } 9	
		Restarted 1909	Still working	3 }	

39. In addition to the above, readings to tide-poles were taken at Bhavnagar and Akyab.

40. The 9 tidal observatories at work were inspected during the year and the registrations have, on the whole, been satisfactory.

41. In the following tables are given the annual and decadal percentages of errors in the predicted times and heights of high and low water at open coast and riverain stations :—

Percentage of errors in Predicted Times and Heights at open coast stations from Automatic Registrations.

Year.	Number of stations.	In Time.		In Height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
1905	7	82	79	96	95	96	97
1906	6	85	81	96	97	94	95
1907	6	84	83	98	99	98	99
1908	6	84	84	98	97	99	99
1909	6	85	86	97	97	97	98
1910	6	81	83	98	98	95	96
1911	6	84	84	98	99	97	98
Average of 10 years	.....	82	80	97	97	96	97

Percentage of errors in Predicted Times and Heights at riverain stations from Automatic Registrations.

Year.	Number of stations.	In Time.		In Height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
1905	2	52	62	72	57	94	92
1906	2	59	53	74	64	92	95
1907	2	58	47	78	60	96	90
1908	2	58	52	77	60	97	92
1909	3	61	59	69	65	93	92
1910	3	57	52	63	71	89	94
1911	3	65	51	68	66	90	90
Average of 10 years	.....	57	55	72	62	93	92

42. Tidal observations during the coming year will be continued at the 9 observatories now working.

LEVELLING OPERATIONS.

43. *No. 17 Party.*—Three detachments were employed as under :—

(i).—No. 1 Levelling Detachment was employed (*a*) on check-levelling the line Khushāb-Shāhpur, (*b*) continuing the line Khushāb-Shāhpur to Lahore, (*c*) levelling from Sargodha along the railway line as far as Kadirpur Rau near Multān, (*d*) levelling at Delhi in connection with the selection of a site for the new Capital. The out-turn amounted to 625 miles, which includes 233 miles of single levelling at Delhi.

The heights of 6 primary bench-marks and 444 secondary bench-marks were determined by double levelling. In the Delhi levelling the heights of 124 secondary bench-marks and 1,852 temporary bench-marks were determined.

The line Shāhpur-Lahore completed the main circuit of levelling Lahore-Rāwalpindi-Khushāb, Shāhpur, Lahore. Accepting the values shown in the line-forms for the new lines, and those shown in Volume XIX B of the Operations of the Great Trigonometrical Survey for the old line, the circuit, 447 miles in length, closes with an error of 0·142 of a foot. This closing error will be slightly altered when the new work is reduced to orthometric terms.

(ii).—No. 2 Levelling Detachment was employed on new levelling (*a*) Dumpep *viâ* Sylhet, Karīmganj and Akhuara to Comilla, (*b*) Karīmganj to Silchār, (*c*) Akhuara as far as possible towards Dacca. The total length of this work was 327 miles and the heights of 26 primary and 264 secondary bench-marks were determined. Among these were included 11 Great Trigonometrical Survey stations.

(iii).—No. 3 Levelling Detachment was employed on new levelling in Burma, (*a*) from Minbu to Salin by road with branch lines along the banks of the Salin Choung, (*b*) from Prome to Rangoon along the Irrawaddy embankments *viâ* Henzāda and Maubin. The out-turn amounted to 393 miles. The heights of 7 primary and 361 secondary bench-marks were determined, including one Great Trigonometrical Survey station.

Progress in connection and construction of standard bench-marks.

The standard bench-marks at Sylhet, Silchār, Comilla, Henzāda, Prome, Salin, and Myanaung were connected. Standard bench-marks have been constructed at the following places and will be connected during the next field season :—Barisāl, Dacca, Mymensingh, Chittagong.

Closing of levelling circuits—During the next field season it is hoped to close 2 levelling circuits in the Punjab and one in Burma.

MAGNETIC SURVEY.

44. *No. 18 Party.*—Two detachments, each under a Provincial officer, were employed on field work, a third detachment was employed at Headquarters in initiating the reduction of the declination data of the Survey.

45. The field detachments were employed on the detailed examination of the Deccan trap area in Central India and Hyderabad State where considerable abnormalities are met with; they also observed at repeat stations in the vicinity of their work.

46. The officer in charge made comparative observations at the 4 Survey base stations and at Alibag magnetic observatory and visited 37 repeat stations.

During the season the values of magnetic elements were determined at 78 new detail stations and 74 repeat stations.

47. *Work during recess.*—The computation of the previous season's field work and the reduction and tabulation of the base station results for 1911 have been completed.

The investigation of the instrumental differences in Horizontal Force has been continued and will, it is hoped, be shortly completed; this investigation which involves the determination of the probable errors of observation of the Survey standard has proved more complex than was anticipated.

48. The mean values of the magnetic elements at the Survey base Stations for 1911 are as follows:—

Observatory.	Latitude & Longitude.	Dip.	Declination.	H. F.	V. F.
	° ′ ″	° ′	° ′	C. G. S.	C. G. S.
Dehra Dūn ...	30 19 19 N 78 3 19 E	N 44 2·0	E 2 29·2	·33238	·32136
Barrackpore ...	22 46 29 N 88 21 39 E	N 30 45·5	E 0 49·9	·37337	·22220
Toungoo ...	18 56 45 N 97 27 3 E	N 23 3·0	E 0 19·3	·38853	·16532
Kodaikānal ...	10 13 50 N 77 27 46 E	N 3 52·0	W 1 0·2	·37515	·02536

PART III.

OFFICE WORK.

I.—HEADQUARTERS OFFICES.

MAP PUBLICATION OFFICE (*vide* index maps at end).

49. The classes of maps, for the publication of which the Headquarters Offices are responsible, may be enumerated as follows:—

(*a*)—The topographical map of India on the scale of 1 inch = 1 mile.

(*b*)—The topographical map of India on the scale of $\frac{1}{4}$ inch = 1 mile.

(*c*)—Geographical maps on the one-millionth scale.

(*d*)—General maps on small scales.

(*e*)—Special maps.

50. The first duty of the offices is to publish the 1-inch and $\frac{1}{4}$-inch maps prepared by the field parties and circle drawing offices from the topographical surveys in progress.

51. *(a) The map of India on the scale of 1 inch = 1 mile.*—During the year 236 sheets of the new map have been received for publication and 159 have been published. A large proportion of the sheets included in the former figure were received towards the close of the year too late for publication.

52. Of the 204 sheets surveyed in 1910-11 only 7 sheets had not been received by the 30th of September 1912, as compared with 64 sheets, the corresponding arrears on 30th September 1911.

53. Index maps Nos. 4, 5 and 6 at the end of this report show the progress of the publication of the new 1-inch map, and the table below gives the annual output of its sheets since the modern topographical surveys were begun:—

Year.	1-Inch (Standard) Sheets Printed.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1905-06	...	...	...	...
1906-07	4	1	...	5
1907-08	16	15	22	53*
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
Total printed ...	246	168	242	656
Total in programme ...	2,160	2,067	2,101	6,328
Number remaining for publication ...	1,914	1,899	1,859	5,672

* Two sheets, 55 $\frac{K}{4}$ and 55 $\frac{K}{8}$, formerly classified as preliminary issues, have been reclassified as modern sheets.

54. In addition, 13 1-inch sheets prepared from modern revenue surveys have been received, and 23 have been published as preliminary editions. One old style sheet prepared from modern revenue surveys has also been received.

55. To maintain the existing stocks of old sheets, or to give effect to important alterations due to the development of communications, 40 sheets on the 1-inch scale have been reprinted.

56. *(b) The map of India on the scale of* $\frac{1}{4}$ *inch* = 1 *mile* (vide *Index map No. 10*).—This map is prepared in "degree sheets" which include 1°×1°, or the area covered by 16 one-inch sheets. The publication of the map is still in its infancy but the fair drawing of several sheets is in progress. The following table shows the work in front of the department in connection with this map:—

	Northern Circle.	Southern Circle.	Eastern Circle.	Totals.
Degree sheets, printed in 1911-12 ...	1	...	...	1
Total number of degree sheets in programme ..	170	140	140	450

57. During the year 4 "degree sheets" have been received at Headquarters and one has been published. Experiments are being made to ascertain the most suitable method of representing hills on 'degree sheets' but no decision has yet been arrived at.

58. Pending the preparation of the new map, 13 sheets on the scale of $\frac{1}{4}$-inch=1 mile have been published in degree sheet form from the maps of old surveys, and 149 sheets of the Indian Atlas and 6 district maps on the same scale have been reprinted to replenish stock.

59. *(c) Geographical maps on the one-millionth scale.*—Nine sheets were published, two of these in outline only without hills and one as a provisional issue. Progress has been made with the compilation and drawing of the sheets remaining to be published. (*Vide* index map No. 11). One old sheet has been reprinted.

60. Until the modern surveys have extended over comparatively large areas and have been published on both of the topographical scales, the one-millionth series of sheets, each of which includes 16 'degree' sheets, and 256 1-inch sheets must continue to be prepared from old surveys. Hitherto the hills on these maps have been shown by shading, but in order to express more fully the available information regarding heights and orography in general, it has been decided to show the orography of the sheets to be published in future by the "layer" system. Under this system the height above sea-level is indicated by a series of colour tints, which in the case of the one-millionth maps will probably be graded from light green for areas between sea-level and 250 feet, through yellows, browns, purples and red to pure white for areas above 25,000 feet. The application of the layer system involves the compilation of approximately accurate contour lines, which may delay the publication of the remaining sheets to some extent, but this disadvantage will be more than counterbalanced by the increase in the amount of information which the 'layered' sheets will give.

61. An international committee, which assembled in London in November 1909, decided that it was desirable that an international map of the world on the scale of 1:1,000,000, should be produced, and that the respective Governments should prepare and publish the sheets of the maps in which their territories were included in a uniform style prescribed by the committee. The Indian Government had already begun the preparation of its own series of one-millionth sheets, and these differ in several important features from the international map, more particularly in the size of the sheets which include 4°×4° instead of the 4°×6° of the international sheets, and in the use of the foot as the unit of height measurements, instead of the metre.

62. The Indian sheets could not be altered to agree with the international series as they form the key to the whole system of nomenclature and arrangement of the topographical sheets, and because the heights and contour intervals must be shown on them in feet; and if the Survey of India is to conform to the international movement, it will be necessary to produce the international sheets as a special series, in addition to the regular one-millionth series of the country. Work on the preparation of the special series can only be undertaken as occasion offers, but a beginning has been made, and the engraving of one international sheet has been begun.

63. (*d*) *Small scale General maps*:—The outline engraving of the new 32-mile map of India and adjacent countries is nearing completion. It has been decided to show the hills on this map by the 'layer' system and to publish it in 1913.

64. The preparation of a new 32-mile map of India showing railway stations has been begun, and is nearly finished. The map will be published before the close of the calendar year.

65. A new edition of the railway, canal and road map of India, scale 32 miles=1 inch, has been in hand.

66. The preparation of a series of maps of Southern Asia on the scale of $\frac{1}{2,000,000}$, (about 32 miles=1 inch), has been under consideration for some time and in response to the demand for a modern map of Persia which has been steadily growing of late years, it was decided last year that a beginning should be made with the Persian sheets; the rough compilations of two of these, 'Northern Persia' and 'Southern Persia', have been received from the Simla Drawing Office; the latter sheet has been drawn and is now under publication, and the drawing of the former is in progress. The two other sheets which include parts of Persia, namely the "Afghānistān" and "Balūchistān" sheets, are still under compilation at Simla.

67. The recent provincial changes are being given effect to on the plates of the general maps of India, and maps of the reconstituted province of Bengal and of the new province of Bihār and Orissa have been prepared.

68. The annual edition of the Railway Administration Map on the 64-mile scale, showing information up to the first of April, was produced in May.

69. Progress has been made in the engraving of the new index maps; 7 of the 42 which include the Indian area have been engraved.

70. *(e) Special maps*:—Numerous special maps, diagrams and camp plans were prepared for the Coronation Durbar at Delhi. In addition to these, a special two-inch topographical map of 'Delhi and vicinity', and a more detailed 4-inch map in 4 sheets with an extract map prepared from it in one sheet, have been published, and a 12-inch enlargement in seven sheets has been begun.

71. As usual a very large number of special maps, plans and diagrams have been prepared for the different departments of Government, for Army Headquarters and for officials throughout India. Among these are census maps, administration maps, postal maps, and railway diagrams.

72. Many of the departmental publications of the Survey of India, its pamphlets and papers, become forgotten and lost, because they are not published in a regular series with a serial number attached to each. It frequently happens now that a Survey officer conducting an enquiry is unaware of the existence of a previous paper dealing with his subject. For this reason Colonel Gore in 1899 initiated the 'Professional Papers' of the Survey Department. These Professional Papers are published in a uniform style and are serially numbered. They are distributed to foreign libraries, universities and surveys. A complete list of the published Professional Papers is included in each successive paper. It has, however, been found that the series of Professional Papers is not by itself sufficient, for there are many reports and papers of the Survey Department which are published for departmental use, and which are not intended for world wide distribution. It has

therefore been decided to have a second series of papers of the Survey of India entitled "Departmental Papers" and numbered serially and to include within it all papers which are being published for departmental use. The essential difference between the series of 'Professional Papers' and the series of 'Departmental Papers' will be their distribution, the former being issued to the public, the latter being confined to the Survey of India and other Government of India departments and to individuals who are specially interested in the progress of the Survey of India.

73. The following departmental publications were printed at Calcutta this year:—

(1). Professional Paper No. 12. "On the Origin of the Himālaya Mountains," by Colonel S. G. Burrard, C.S.I., R.E., F.R.S., Surveyor General of India.

(2). Topographical Hand-book:—

Chapter II.—"Constitution and Organisation of a Survey Party."

Chapter IV.—"Traversing and its Computation."

Chapter VI.—"Fair Mapping."

Chapter VII.—"Trans-frontier Reconnaissance."

Chapter IX.—"Forest Surveys and Maps."

Chapter X.—"Reproduction of the sheets of the one-inch Map."

(3). "Report on a trial of the Equipment of the 1st, (Prince of Wales' Own), Sappers and Miners for reproducing maps in the field" by Lieutenant A. A. Chase, R.E.

74. A list of the departmental publications printed at Dehra Dūn this year is given on page 30 in the Report from the Dehra Dūn Offices.

DRAWING OFFICE.

75. The Drawing Office continued its normal work of compiling and supplying material for the engraving of all the general small scale maps of the department and the fair drawing of such of them as are printed by heliozincography, the maintenance and correction of the office copies of all the maps of the department, and the bringing up to date of old maps which had to be reprinted. During the year work was done on 29 sheets of the India and Adjacent Countries Series, on the scale of $\frac{1}{1,000,000}$, on 2 sheets of the new Southern Asia Series, on the scale of $\frac{1}{2,000,000}$, and on 37 sheets of the general maps of India, on various scales.

The preparation of degree sheets from the old Atlas sheets has been continued and 21 such sheets have been taken in hand.

Of maps, on various scales, which had to be reprinted, 89 were worked on during the year.

Corrections or additions were made to 125 sheets on various scales which had been drawn by parties and circles.

Of indexes, provincial and district maps, and large scale plans of cities and cantonments, 81 were worked on during the year. 66 sheets of extra-departmental work were taken in hand. Amongst these were many maps and plans for the Census officials, and one entirely new drawing for the map showing the name and position of every railway station in India.

44 sheets of miscellaneous specimens, symbols, &c., for departmental use were taken in hand.

76. The work of the office copy or record section is always heavy; every new railway and canal and every addition to main roads, or change in boundaries has to be added on the office copies of all the maps of the department; the recent provincial rearrangements in Bengal alone affected 260 of our sheets.

ENGRAVING OFFICE.

77. The Engraving Office has been employed on maps on the scales of 4 miles to 1 inch and $\frac{1}{1,000,000}$, and on all the general smaller scale maps of the department.

Considerable progress has been made with the new edition of the 32-mile map of India in 12 sheets and this map will be finished during the coming year.

A considerable amount of work still remains to be done on the new 64-mile map of India, which will not be finished for 2 or 3 years to come.

Corrections have been made to the 96, 128, 192 and 256-mile maps of India and a new map on the 128-mile scale has been published during the year.

The engraving of the first degree sheet, (No. 38 N), based on surveys subsequent to 1905 has been taken up and is nearly finished, this map will be published early next year. Five sheets, (Nos. 34, 47, 53, 83, 94) of the $\frac{1}{1,000,000}$ series have been worked on during the year, and one sheet of the International map on this scale was commenced. Numerous district, provincial, miscellaneous and index maps have been prepared, or corrected. Amongst the publications under this head is a new edition of the map of Calcutta on the scale of 6 inches to 1 mile.

78. The normal employment of the office for some years to come will be as follows:—

(*i*) The completion of the new 32-mile map of India and Adjacent Countries, and the revision of the plates of the 64-mile map.

(*ii*) The engraving of those sheets of the India and Adjacent Countries series, on the scale of $\frac{1}{1,000,000}$, and of the degree sheet and $\frac{1}{2}$-inch series which are likely to be most in demand, as including important towns, big military centres and manœuvre areas.

(*iii*) One sheet of the international map of the world on the scale of $\frac{1}{1,000,000}$, is in hand, and additional sheets will be taken up as occasion offers.

PHOTO.-LITHO. OFFICE.

79. There has been a general increase of work over 1910-11 both in the number of maps printed and in the total number of pulls, which has necessitated a considerable expenditure on overtime work. During the year, 231 sheets in new 1-inch (standard) form were published, including preliminary and provisional editions, new publication and reprint editions to replenish stock. Of these 222 were in colours, 4 in black and brown, and 5 in black only. This shews an increase of 90 such sheets over 1910-11, and of 15 over 1909-10. Sixty-one degree and fourteen $\frac{1}{1,000,000}$ sheets, (including reprints, &c., as above), were also published.

80. Some progress has been made in connection with the production of layer maps. The difficulties in producing and securing good registration of the various layer tints have been successfully surmounted, and satisfactory results have been attained. Two layer maps are in proof stage at present, and will shortly be printed.

81. With a view to keeping abreast with the latest printing methods, a new rubber offset printing machine has been installed. It is too early yet to judge the results of printing from rubber, but it is hoped that the new method will offer material advantages.

82. In the month of March this year the large Zeiss "Apochromatic Plānar" lens indented for in 1906 arrived. The makers experienced great difficulty in making the prism for this lens, and it is understood that over three were rejected by them as unsatisfactory before a successful result was attained. The lens has a focal length of 1,700 mm, working at an aperture of $\frac{F}{12\cdot5}$. It has been tested at full scale on a 46½ inch × 33 inch plate, and found quite satisfactory. With a small aperture, a plate 50 inches × 40 inches can easily be covered.

83. A glass plate polishing machine has also been installed.

TABULAR STATEMENT OF OUT-TURN OF PHOTO-LITHO OFFICE.

1	2	3	4	5	6	7	8	9
Year.	Cost of office.	Value of out-turn at cost-rates.	Recovered in cash or by book-debit. *	Number of impressions pulled. † (Litho. only here shewn).	Number of maps printed.			Remarks.
					Departmental.	Extra departmental.	Total.	
	Rs.	*Rs.*	*Rs.*					
1909-10 ...	1,54,494	2,13,894	51,586	1,574,180	2,697	1,053	3,750	
1910-11 ...	1,64,193	1,77,900	50,693	1,383,147	2,559	1,104	3,663	
1911-12 ...	1,47,867	2,01,394	24,904†	1,564,496	2,686	1,263	3,949	

* This shows a decrease. This is due to the fact that the Map Record and Issue Office now despatches and charges for nearly all the extra-departmental maps printed by the Photo.-Litho. Office.

† This as in statements of previous years only includes litho. impressions.

In addition, there were 60,056 half-tone pulls and 437,820 line-block pulls, (chiefly Weather Charts).
as against { 102,900 ,, ,, and 111,300 ,, ,, in 1910-11.
{ 114,846 ,, ,, and 68,390 ,, ,, in 1909-10.

The output of the Type Section is not included in the above statement.

The Type Section published 7,988 pages or items, 1,131,012 copies, 2,014,766 impressions.
as against { 14,604 ,, or ,, 1,235,161 ,, 2,104,755 ,, in 1910-11.
{ 12,185 ,, or ,, 1,435,093 ,, 2,615,735 ,, in 1909-10.

MAP RECORD AND ISSUE OFFICE.

84. The gross face value of the maps received from the printing offices during the year amounted to Rs. 2,28,331. This sum includes Rs. 16,235, and Rs. 13,066, the face value of maps printed in the Engraving Office and at Dehra Dūn respectively.

85. The following table shows the maps printed and received and their face values :—

Class of maps.	Scale.	Number of different maps of each class received.		Value.
		New publications and New Editions.	Reprints.	
				Rs.
(I) Geographical maps	Small & Various	2	2	5,712
(II) India and Adjacent Countries (Helio) ...	$\frac{1}{1,000,000}$	10	2	5,300
(III) Quarter-inch sheets—				
(*a*) Degree sheets (Modern) ...	1 inch= 4 miles	.....	3	1,500
(*b*) do. (Prely. & Provl.) ...	1 inch= 4 miles	35	1	16,636
(*c*) do. (from old material)...	1 inch= 4 miles	13	3	4,950
(*d*) (Old style sheets)	1 inch= 4 miles	1	9	4,020
(IV) 1-inch (Standard) sheets—				
(*a*) (Modern)	1 inch= 1 mile	159	2	81,149
(*b*) (Preliminary)	1 inch= 1 mile	23	.....	10,730
(*c*) (Old style)	1 inch= 1 mile	13	27	17,467
(V) Provincial maps	1 inch=16 miles 1 inch=32 miles	1	3	1,780
(VI) District maps	1 inch= 4 miles	.....	6	1,600
(VII) Atlas sheets	1 inch= 4 miles	.....	149	14,477
(VIII) Administration Report maps ...	1 inch= 8 miles	1	17	675
(IX) Plans of Cities and Cantonments ...	Various	34	.....	12,809
(X) Triangulation and traverse charts ...	Various	22	47	1,465
(XI) Index maps	Various	24	5	3,030
(XII) Miscellaneous maps	Various	273	35	45,031
Totals ...	.....	611	311	2,28,331
Corresponding totals for 1910-11	.....	541	325	2,17,431

86. The total number of printed maps issued during the year was 2,88,633 of an aggregate value of Rs. 1,39,270. The details of the sales were as follows:—

Sales to	Number of maps.	Values.
		Rs.
Government officials	220,737	71,634
India Office	1,792	2,061
Departmental issues	38,235	42,734
Private individuals	24,410	19,652
Agents	3,459	3,189
Totals for 1911-12 ...	288,633	1,39,270
Corresponding totals for 1910-11 ...	230,948	1,37,167

MATHEMATICAL INSTRUMENT OFFICE.

87. During the year under report, *viz.*, from 1st April 1911 to 31st March 1912, there was a marked improvement in the demands made on this office, compared with those of the preceding 2 years. This is clearly illustrated by the following table:—

Value of Instruments issued to Public Officers.

1909-10.	1910-11.	1911-12.
Rs.	*Rs.*	*Rs.*
2,38,332	2,65,184	3,25,633

As a result, the profit and loss statement shows a profit of Rs. 6,204, (as against a loss of Rs. 6,891, shown in the statement for 1910-11), on this head.

88. On the other hand, there was a shrinkage in the work done as the following table will show:—

Value of work done in the workshop.

1909-10.	1910-11.	1911-12.
Rs.	*Rs.*	*Rs.*
1,88,411	2,01,329	1,74,871

The profit and loss statement shows a loss of Rs. 4,716, (as against a gain of Rs. 10,673, shown in the statement for 1910-11), on this head. This loss was partly attributable to the absence of the Junior Assistant Manager on leave, the work during his absence devolving largely on more or less untrained assistants.

89. The following table shows the number of employés at the end of each of the last 3 years:—

1909-10.	1910-11.	1911-12.
486	318	330

90. The following table shows the average number of employés and their pay :—

1909-10.	1910-11.	1911-12.
353 at Rs. 79,810	296 at Rs. 59,836	297 at Rs. 62,981

91. It may be noted as pointed out in last year's report, that certain standing charges, (representing supervision, rent, interest on plants and material, depreciation, clerical labour, &c.), have to be incurred, irrespective of the work coming to the office, and consequently, the so-called profit and loss in connection with the working of the Mathematical Instrument Office depends on the demands received for instruments to be supplied, and for work to be done. In calculating profit and loss, a percentage is allowed to be taken as credit, (25 % over book value in the case of issues and 10 % in the case of work done), and an increase of demands means an increase in the amount of this percentage, resulting in probably a gain, and a shrinkage of demands means a reduction in the amount of the percentage, resulting in probably a loss, the standing charges remaining the same in both cases.

92. Below are given the usual comparative figures for the last three years :—

	1909-10.	1910-11.	1911-12.
	Rs.	*Rs.*	*Rs.*
Total issues to Public Offices as shown in the Profit and Loss statements of stores.	2,38,332	2,65,184	3,25,633
Value of repairs to instruments received for repairs and returned in a serviceable condition.	55,774	64,156	55,941
Value of instruments received from Government Officers when no longer required.	53,446	33,428	37,228
Book value of the stock of instruments, &c., in Serviceable Store.	10,22,554	9,20,925	7,46,047
Book value of the stock of instruments, &c., in Repairable Store.	81,381	69,371	70,460
Total value of work done in the Workshop ...	1,88,411	2,01,329	1,74,871
Value of instruments manufactured in Workshop for Serviceable Store.	53,035	61,698	61,431
Value of instruments purchased locally ...	1,948	2,880	4,578
Value of instruments and materials obtained from England through the Director General of Stores.	2,12,921	40,844	47,148

93. During the year the stock of all the three stores, the Serviceable, the Repairable and the Material Stores, was taken, and the discrepancies noticed have been adjusted.

94. The working of the office on the whole has been very satisfactory, and the aims of the Profit and Loss accounts have been carried out, so that the office has done its work without practically either gain or loss.

95. During the year the following items of importance occurred :—

(1) The Abor Expedition, Miri and Mishmi Missions were equipped.

(2) The Field Press was again got ready for trial at manœuvres.

(3) A little progress was made in the manufacture of lenses.

(4) The extension of the dividing shop was completed.

II.—DEHRA DŪN OFFICES.

SPECIAL OPERATIONS.

96. The new apparatus for the comparison of standards of length which has been designed by Sir David Gill, K.C.B., F.R.S., is on its way out from England, and parts of it have already arrived.

97. The apparatus is primarily concerned with the measurements of geodetic bases but is of so complete a nature that with its aid it will be possible to determine the length and thermal constants of almost any bar that has suitable terminal marks inscribed on it.

98. There are two distinct and separate parts of the apparatus. The one is for determining the lengths of the wires with which bases are measured in the field, and the other for determining the length of the bar with which the wires have been measured, by comparison with the primary standard.

99. The primary standard will probably be a metre of pure nickel. It had been intended to employ a metre of silica-glass, which seemed to have many advantages over other materials, but the metre of this kind in the possession of the National Physical Laboratory at Kew has shewn signs of secular change, and it would therefore be unsafe, at any rate until further knowledge of its behaviour has been accumulated, to look upon it as a primary standard.

In addition to the metre of pure nickel there will be a metre of invar, (36 % nickel, 64 % steel), and a 4-metre bar also of invar.

The last named bar will be used for determining the 24 metre length with which the wires are compared.

100. The equipment formerly in use in India consisted of a set of 6 Colby Compensation bars and microscopes and a 10ft. standard bar of wrought iron. The latter on account of the large size and somewhat irregular outline of the dots that define its length, is unsuitable for work of the refinement that is nowadays looked for, and the Compensation bars, though highly ingenious, are laborious to use, and their complexity makes it difficult to account and allow for the residual uncompensated changes of length, due principally to differences in the temperatures of the brass and the iron bars of which they are composed.

101. The Trigonometrical Survey has never possessed any apparatus for determining the coefficients of expansion of its standards of length and it was very necessary that this deficiency should be made good.

102. The seismograph has been in action and certain improvements have been effected. The pillar even yet appears not to have settled finally, and adjustments for period have to be made from time to time. A number of earthquakes have been recorded and the distance of the epicentre estimated, showing satisfactory agreement with the estimate from the Simla seismograms.

103. Photographs of the sun have been taken on 336 days, the sun being obscured by clouds on the remaining days.

104. Meteorological observations have been continued as usual at 10 a.m. and 4 p.m. throughout the year. As the results, with the exception of rainfall readings, are no longer required by the Meteorological Department, certain changes in the times of observing will be made from January 1913, so as to make the observations of greater practical use for Survey operations.

COMPUTING OFFICE.

Geodetic work.

105. Numerous computations, comprising conversion of coordinates for trans-frontier degree triangulation charts, deduction of dynamic and orthometric heights of rock-cut bench-marks along various lines of levelling, reduction of azimuth observations taken on the Abor Expedition, and preparation of Table XVII, Auxiliary Tables, have been carried out. Work also has been done in connection with certain magnetic questions, size of the Earth, and the International Atlas.

106. Twenty-one spirit levelling pamphlets and 82 triangulation charts have been passed through the press and printed during the year: the total number of the latter now amounting to 112.

107. The following publications have been printed:—

(*a*) "Note on a change of the axes of the Terrestrial Spheroid in relation to the triangulation of the Great Trigonometrical Survey of India" by J. deGraaff Hunter, M.A.

(*b*) "Miscellaneous papers relating to the measurement of Geodetic Bases by Jäderin Invar Apparatus."

(*c*) Professional Paper No. 13. "Investigation of the theory of Isostasy in India," by Major H. L. Crosthwait, R.E.

(*d*) "On the Deformation resulting from the method of constructing the International Atlas of the World on the scale of one to one million by M. Ch. Lallemand." Translated by J. Eccles, M.A.

(*e*) "A note by Major C. L. Robertson, C.M.G., R.E., on the representation of hills."

Arrangements have been made for the storage of all the Professional Forms which are now being supplied from this office.

Geographic Work.

108. Some topographical triangulation has been finally adjusted, and some is at present in hand. Explorations in Tibet made by Indian Explorers at different times have been combined chronologically in one book, which is now being sent to press.

109. The following reports have been printed:—

(*a*) Report on the Survey Operations, Mishmi Mission, 1911-12.

(*b*) Ditto ditto Hkamti Long Mission, 1911-12.

(*c*) Ditto ditto Miri Mission, 1911-12.

Preservation of Trigonometrical Stations.

110. 1,117 stations were repaired by the district officers at a cost of Rs. 6,612-4-3. Out of 340 districts from which reports are due annually, 20 failed to make returns.

DRAWING SECTION.

111. The following table shows the volume of work undertaken:—

Class of map.	Number of sheets in hand.	Number of sheets drawn and sent to press.
Scientific diagrams and charts	0	9
Geographical maps, $\frac{1}{1,000,000}$ scale	4	1
Do. do. Layer system, (specimen) ...	1	0
Do. do. smaller scale	2	2
Miscellaneous indexes, plans, diagrams, &c. ...	2	5
Triangulation charts	34	58
Levelling charts	1	23
Coronation Durbar maps	0	8
Special maps—Hkamti Long Mission ...	0	3
Do. do. for Doctor Stein	0	17
Extra Departmental maps—(1) District map of Hoshiārpur, and (2) Country between Ambāla and Pāniput.	0	2

PHOTO.-ZINCO. SECTION.

112. 1,550 maps and diagrams were photographed against 1,844 in 1910-11, very little work was received for photographing during the months of February, March, and April which accounts for the slight falling off.

113. The number of impressions pulled was 289,116 against 294,118 in the previous year. The lithographic machine was employed throughout the year printing the maps of Dr. Stein's exploration, cantonment maps, forest maps, triangulation and levelling charts.

114. The letter-press machine and stereo-typing plant have been installed and erected during the year. The letter-press machine was employed throughout the year printing departmental forms, the number of impressions pulled was 265,615.

FOREST MAP OFFICE.

115. The number of maps, of the gross face value of Rs. 14,699, issued to the Forest and other officials and to the public during the year, was 10,453, which is a decrease of 6,859 from last year. The sum realized by sales amounted to Rs. 2,681, against Rs. 1,724 in the previous year. Of this amount, Rs. 2,096 was adjusted by book-debit and Rs. 585 accrued from sales to private individuals and trading companies.

116. The following table shows in abstract form, the work dealt with by the Office :—

Class of map.	Number of Sheets.		
	In hand.	Drawn and sent to press.	Published.
1-inch, 2-inch, and 4-inch maps of Forest Surveys	177	99	108
Provincial, Divisional, and District Forest maps ...	15	12	2
Working Plans and Miscellaneous maps ...	17	26	16
Totals ...	209	137	126

III.—CIRCLE AND LOCAL DRAWING OFFICES.

NORTHERN CIRCLE DRAWING OFFICE.

117. The normal main work of the office was the examination of 1-inch (standard) sheets drawn by the various parties, the completion to margin and examination of a few sheets owing to small additional surveys, the drawing of degree sheets, and the examination of a few 1-inch (standard) sheets compiled and drawn in the late United Provinces Drawing Office.

118. The following is a summary of the work in hand and sent to press :—

Class of map.	Scale.	Number of Sheets.	
		In hand.	Sent to press.
1-inch (standard) sheets	1 inch = 1 mile	62	160
Do. do. (2nd Edition) ...	Do.	0	3
Do. do. (Reprints) ...	Do.	1	1
Do. do. (Preliminary) ...	Do.	0	6
Degree sheets	1 inch = 4 miles	9	4
4 Cantonment maps	12, 16, 64 inches = 1 mile	9	38
Miscellaneous maps, (Delhi)	...	0	4

SOUTHERN CIRCLE DRAWING OFFICE.

119. The final examination of 55 1-inch (standard) sheets and the fair drawing of 5 1-inch (standard) sheets, 4 degree sheets, 4 sheets of the map of the Periyār and Pambiyār Catchment Areas and 20 special forest editions were completed ; the fair drawing of 25 standard sheets which were received incomplete from parties was also completed. The fair drawing of 2 1-inch (standard) sheets and 3 degree sheets was commenced but not completed. Considerable assistance was given to parties to complete their current mapping. 13 pupils were trained in drawing and typing.

120. The Photo.-Zinco. Section undertook most of the photographic and Vandyke work required by the parties.

121. The only sheets reported as surveyed in 1910-11 which were not submitted for publication before the 30th September 1912 were the following :—

Sheets 48 $\frac{P}{11 \& 15}$ and 58 $\frac{B}{8}$.

EASTERN CIRCLE DRAWING OFFICE.

122. During this season the office dealt with the maps of season 1910-11, when there were only 3 parties in the circle.

123. Out of the 41 sheets completely surveyed, 40 were sent in by the parties for examination and publication. All of these but one were forwarded to Calcutta for publication before the end of the season under report, and the remaining one was forwarded in October 1912. Fifteen of these sheets contained foreign territory, of which only reconnaissance surveys on the $\frac{1}{4}$-inch scale are in existence, and they were completed to margin in the drawing office by enlargement of the $\frac{1}{4}$-inch surveys. Twelve sheets were submitted otherwise incomplete by the field parties, and were completed in the drawing office, and during recess 12 draftsmen were lent to the parties to assist in the mapping of the current season.

124. One degree sheet map was drawn and forwarded to Calcutta for publication and 8 are now in hand.

125. One cantonment map was drawn and forwarded for publication and also one triangulation chart.

BENGAL DRAWING OFFICE.

(Standard Mapping Section).

126. The following 14 1-inch (standard) maps with a mapped area of 3,477·66 square miles have been submitted during the year for the publication of a preliminary edition of each:—

72 $\frac{G}{2, 6}$, $\frac{K}{4, 8}$, $\left[\frac{K}{3 \& 7}\right]$, (old style 30 inches × 15 inches, brought up to margin for a second edition), $\frac{L}{6, 10, 13, 14}$, $\frac{O}{8}$, $\frac{P}{1, 2,}$, 73 $\frac{B}{2, 6}$,

and the following 17, with an area of 3,252·72 square miles, have been compiled during the year and submitted for the preparation of prints for supplementary survey:—

72 $\frac{L}{1, 2, 3, 4, 7, 8}$, 73 $\frac{B}{1, 3, 5, 7, 8, 9, 10, 11, 13, 14, 15}$.

127. The following four 1-inch (standard) sheets which were completed in former seasons for surveyed areas are still held up for the incorporation of the material of districts Jalpaiguri, Gaya and Hazaribagh, no new work having been done in them during the year:—

78 $\frac{B}{6, 8}$, 72 $\frac{G}{16}$, $\frac{H}{13}$.

128. The following 57 1-inch (standard) sheets with an approximate area of 13,942·46 square miles are in hand for the publication of either a preliminary edition or of prints for supplementary survey:—

63 $\frac{O}{14, 15}$, 64 $\frac{K}{12, 16}$, $\frac{L}{9, 13}$, $\frac{O}{4, 9, 13}$, $\frac{P}{1, 5}$, 72 $\frac{C}{3, 4, 6, 7, 8, 10, 11, 12, 14, 15, 16}$, $\frac{G}{3, 4, 7, 8, 11, 15}$, 72 $\frac{L}{11, 12, 15, 16}$, 73 $\frac{B}{4}$, $\frac{C}{1, 2, 3, 4, 5, 6, 7}$, $\frac{E}{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}$.

Five sheets, *viz.*:—72 $\frac{C}{14}$ and 72 $\frac{L}{11, 12, 15, 16}$, were practically ready but unfortunately could not be sent in for publication before 1st October and hence could not be included among the maps submitted for publication during the year.

129. In addition to the above, the following 32 1-inch (standard) sheets which were drawn in previous years in pencil for thāna mapping purposes are still in pencil but will gradually be inked up for publication:—

63 $\frac{O}{16}$, 64 $\frac{O}{6, 7, 8, 10, 11, 12, 14, 15, 16}$, 72 $\frac{O}{12, 16}$, $\frac{P}{3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15}$, 73 $\frac{I}{1, 2, 3, 9, 13}$, 73 $\frac{M}{1, 5}$.

130. The following examination, correction and colouring work has also been done:—

(*a*) 10 uncorrected proofs of 1-inch (standard) sheets have been examined and corrected.

(*b*) Fiscal limits and cultivation have been coloured on 20 unpublished black prints of 1-inch (standard) sheets.

(*c*) 26 published black prints of 1-inch (standard) sheets have been coloured.

PART IV.

WORK FOR OTHER GOVERNMENT DEPARTMENTS.

131. As in previous years the Riverain Detachment of the Northern Circle was exclusively employed on the riverain and rectangular surveys required by the Punjab Government (*ride* page 7).

132. The Mathematical Instrument Office supplies and repairs certain classes of instruments for every Government department in India including the Army Department.

133. Various forest surveys were carried out by the parties in the different circles (*ride* the special report on Forest Surveys, page 13).

134. The survey of the Quetta Cantonment and civil station was carried out at the instance of the Chief Commissioner and Agent to the Governor General in Balūchistān (*ride* page 7).

135 The survey and fair-mapping of the Cantonment of Santa Cruz were completed (*ride* page 8).

136. The Pambiyār Catchment area in the Travancore State of Madras was surveyed and a combined map in 4 sheets on the 2-inch scale of the Periyār and Pambiyār Catchment areas was fair drawn.

137. A section of No. 10 Party was employed in giving practical training in cadastral surveying to officers of the Burma Land Records Department until the 1st April 1912, when it was transferred to that department (*ride* page 9).

138. Survey detachments were attached to the Abor Expedition, the Miri and Mishmi Missions on the N. E. frontier, and to the Hkamti Long Mission in North Burma, and executed reconnaissance surveys for the Foreign and Army Departments.

139. The reproduction, for other departments, of maps, plans, and illustrations that do not require to be redrawn, does not interfere with the normal work of the Survey of India and is always undertaken when asked for. On the other hand, the amount of drawing and compilation that can be done for extra-departmental purposes is limited, and is necessarily confined to urgently required and important work.

140. During the year special drawing and compilation have been done for the following:—

The Government of India.

Local Governments and Administrations.

The Chief of the General Staff.

The Coronation Durbar Committee.

he Railway Board.

The Census Commissioner.

The Post Master General.

Maps, plans, or illustrations were reproduced for the following in addition :—

General Officers Commanding Divisions and Brigades.
The Director-General, Military Works.
The Director, Geological Survey of India.
The Director-General, Commercial Intelligence.
The Director-General of Observatories.
The Consulting Architect to the Government of India.
The Officer on Special Duty for Enquiry into Prices.
The Engineer Officer on Special Duty, Delhi.
The Chief Inspector of Mines in India.
The Indian Museum.
The Superintendents, Government Printing.
The Director-General of Archæology in India.
The Superintendent, Hindu and Buddhist Monuments.
The Controller of Patents and Designs.
The Great Indian Peninsula Railway.
The East Indian Railway.
The Bengal-Nagpur Railway.
The Eastern Bengal State Railway.
The Bengal and North-Western Railway.
The Karāchi Extension Railway Survey.
Local Census Superintendents.
Sanitary Commissioners.
Chief Engineers.
Forest Department.
Police Department.
Postal and Telegraph Department.
Agricultural Department.

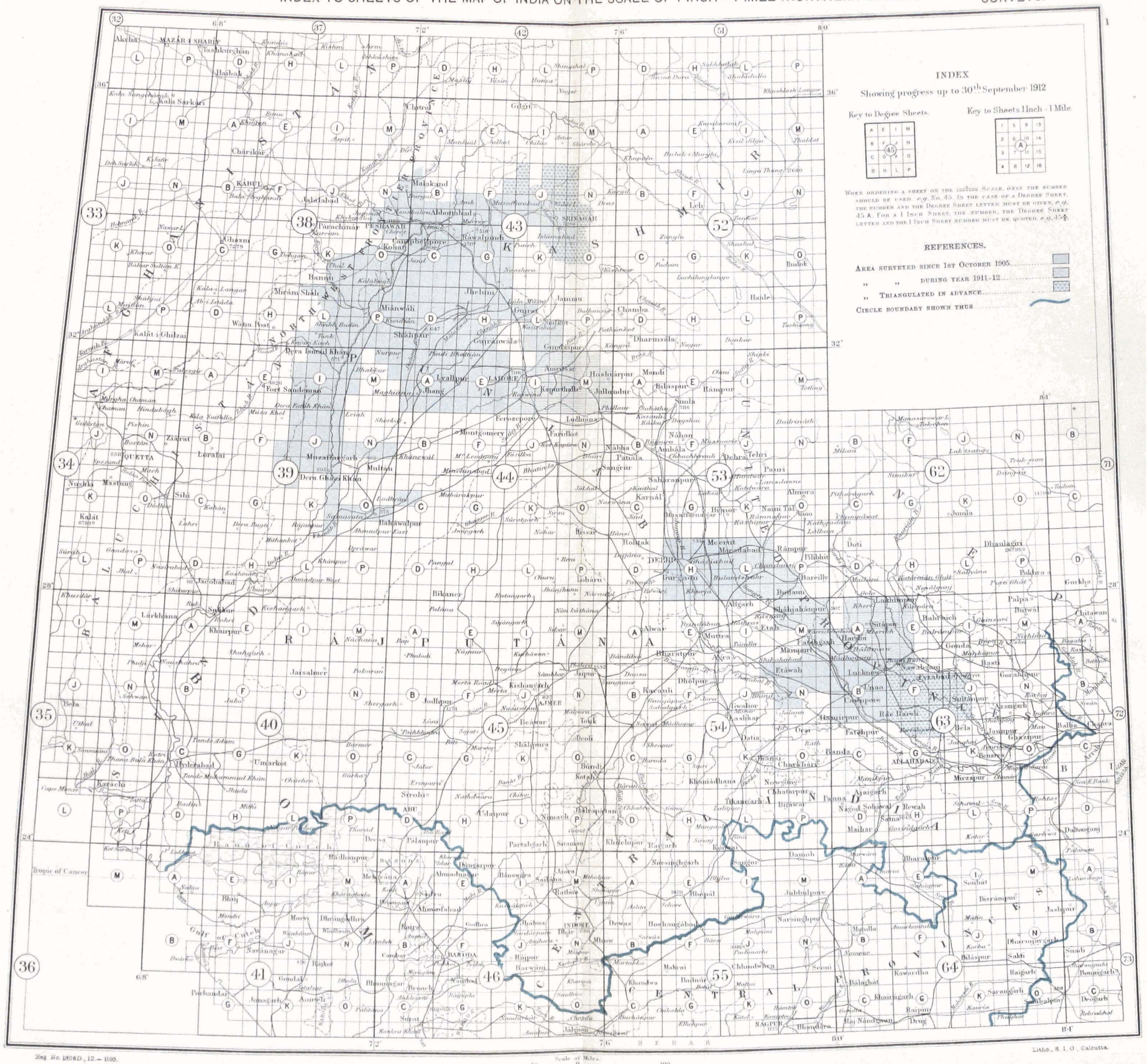
141. Some work was also done for public bodies or societies, such as the Port Trust Commissioners, Calcutta and Madras, the Indian Astronomical Society, the Calcutta School of Art, the Photographic Society of Bengal, &c., and in a few cases, for private firms.

142. A surveyor from No. 1 Party accompanied Mrs. Bullock Workman's expedition and surveyed an area of 866 square miles on the scale of $\frac{1}{2}$ inch = 1 mile on and in the vicinity of the Siāchen glacier in Baltistān. The ordinary pay and travelling expenses of the surveyor were paid by the Survey of India, all other extra expenditure being met by Mrs. Bullock Workman on the understanding that the map would be placed at the disposal of the Survey of India on the return of the expedition.

143. 17 maps were drawn and compiled and 30 maps reproduced at Dehra Dūn of Dr. Stein's explorations in Chinese-Turkestān and Western China, 1906—08.

144. A number of astronomical, barometrical, and hypsometrical observations, taken by Captain Bailey in the course of a journey from Pekin across China to Sadiya, India, have been worked out in the Computing Office at Dehra Dūn.

145. A section of the Simla Drawing Office is employed solely on miscellaneous work for the Military and Foreign Departments, and has turned out a large number of maps.



Reg. No. 1208D., 12.—1100.
Litho., S. I. O., Calcutta.

INDEX TO SHEETS OF THE MAP OF INDIA ON THE SCALE OF 1 INCH = 1 MILE (SOUTHERN CIRCLE).

SURVEYS.

INDEX

Showing progress up to 30th September, 1912

Key to Degree Sheets.

Key to Sheets 1 Inch=1 Mile.

When ordering a sheet on the 1 inch Scale, only the number should be used, *e.g.* No. 58. In the case of a Degree Sheet, the number and the Degree Sheet letter must be given, *e.g.* 58 A. For a 1 Inch Sheet, the number, the Degree Sheet letter and the 1 Inch Sheet number must be quoted, *e.g.* 58 $\frac{A}{5}$

REFERENCES.

Area surveyed since 1st October 1905 .....

" " during year 1911-12 .....

" Triangulated in advance .....

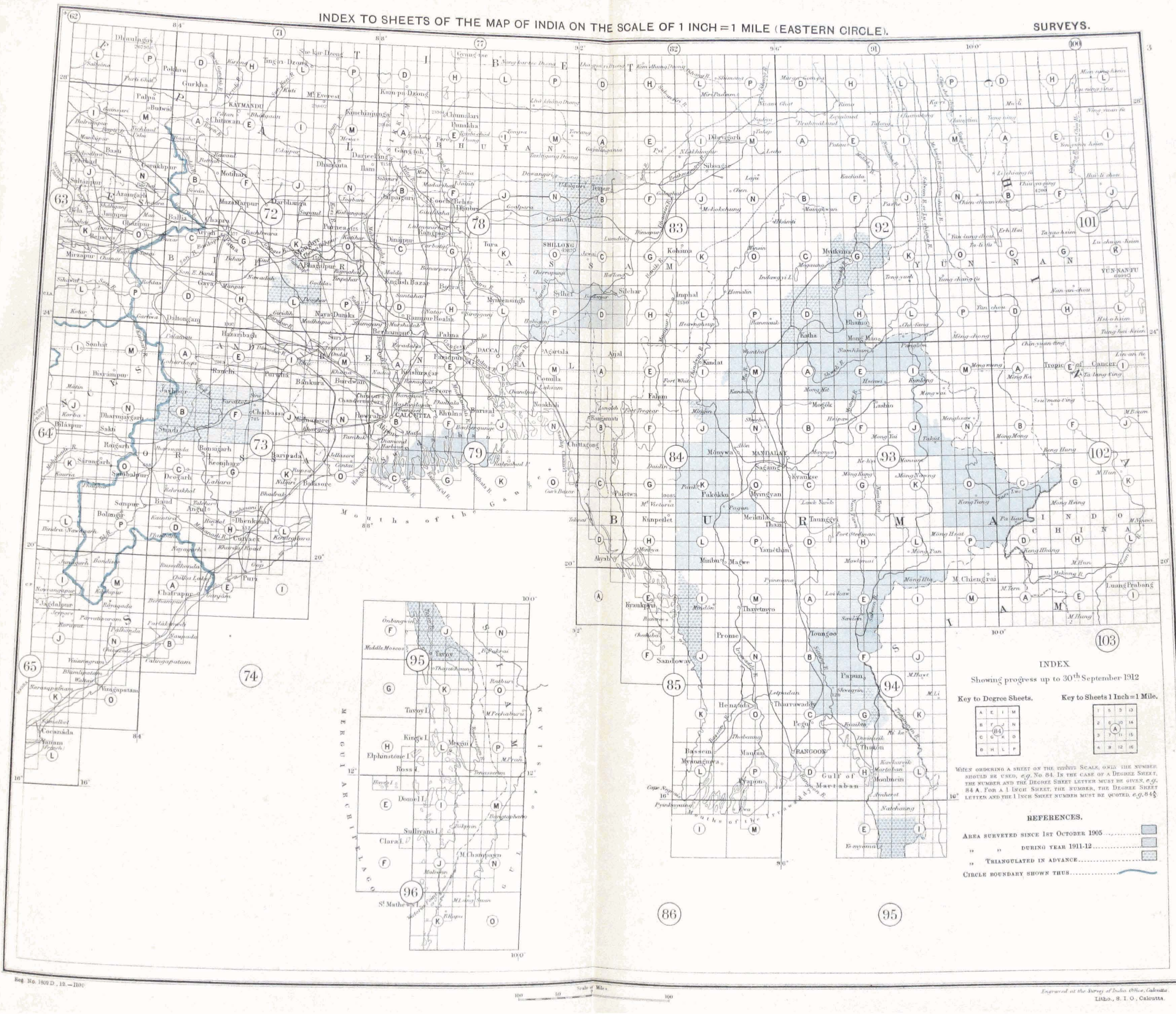
Circle boundary shown thus .....

Reg. No. 1710 D., 12.—1100.

Litho., S. I. O., Calcutta.

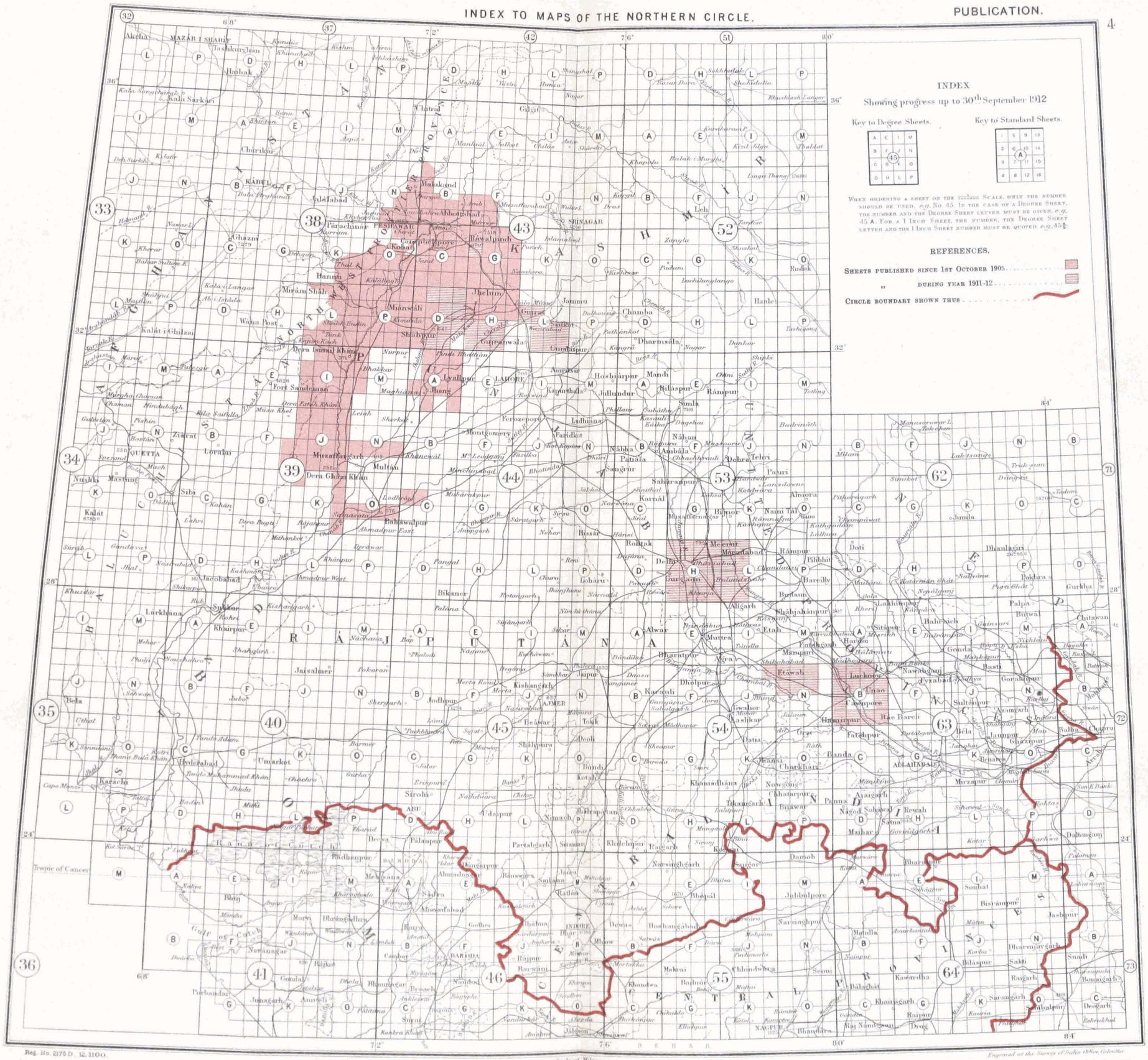
INDEX TO SHEETS OF THE MAP OF INDIA ON THE SCALE OF 1 INCH = 1 MILE (EASTERN CIRCLE).

SURVEYS.



Reg. No. 1809 D., 12.—1100

Engraved at the Survey of India Office, Calcutta.
Litho., S. I. O., Calcutta.



Reg. No. 2175 D. 12. 1100.
Engraved at the Survey of India Office, Calcutta.
Litho., S. I. O., Calcutta.

INDEX

Showing progress up to 30th September, 1912

Key to Degree Sheets.

Key to Standard Sheets.

When ordering a sheet on the 1inch Scale, only the number should be used, *e.g.* No. 58. In the case of a Degree Sheet, the number and the Degree Sheet letter must be given, *e.g.* 58 A. For a 1 Inch Sheet, the number, the Degree Sheet letter and the 1 Inch Sheet number must be quoted, *e.g.* $58\frac{A}{5}$

REFERENCES.

Sheets published since 1st October 1905 .....

" during year 1911-12 .....

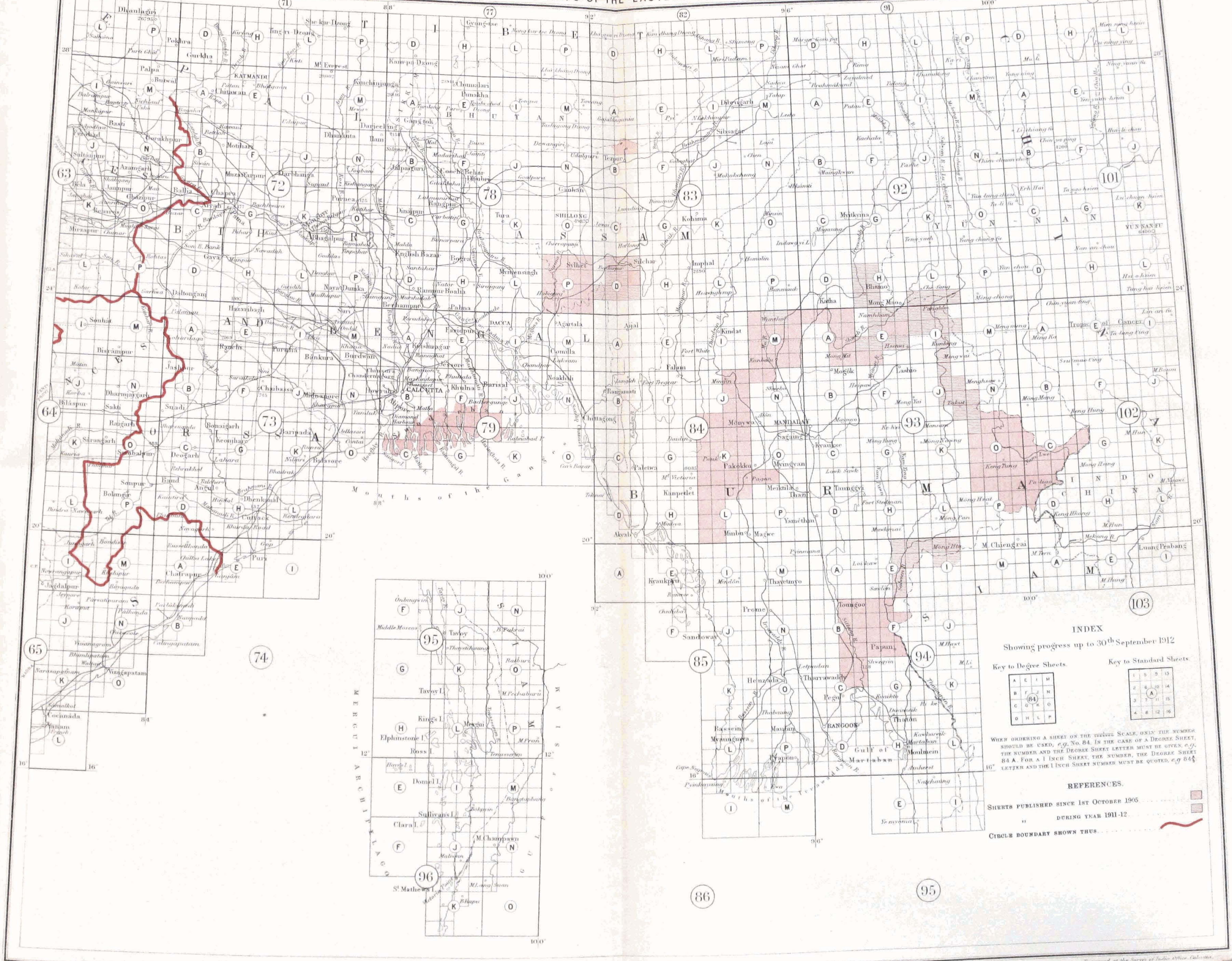
Circle boundary shown thus .....

Reg. No. 2175 D., 12. 1100.

Engraved at the Survey of India Office, Calcutta.

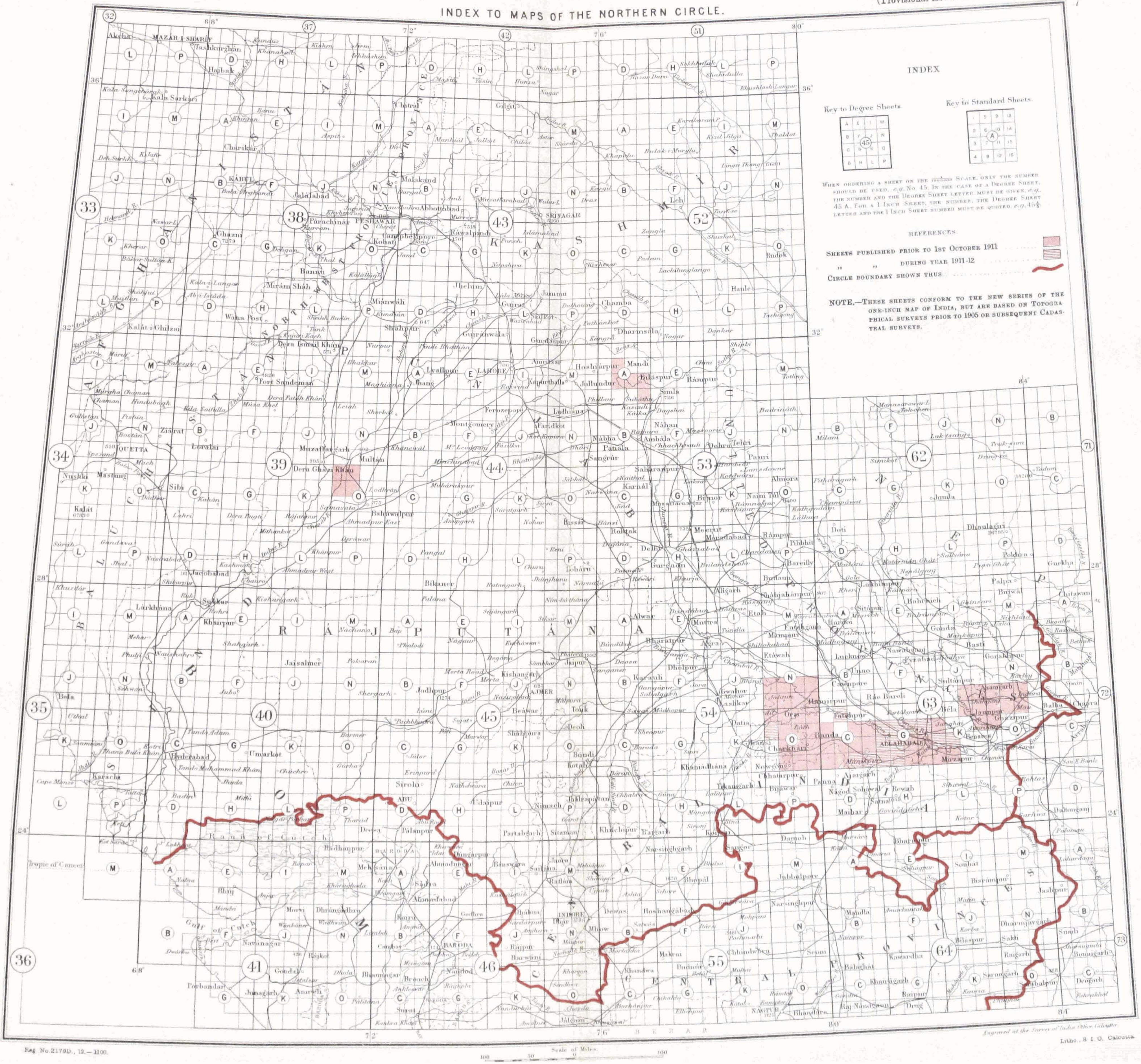
Litho., S. I. O., Calcutta.

INDEX TO MAPS OF THE EASTERN CIRCLE.



When ordering a sheet on the ——— Scale, only the number should be used, e.g. No. 84. In the case of a Degree Sheet, the number and the Degree Sheet letter must be given, e.g. 84 A. For a 1 Inch Sheet, the number, the Degree Sheet letter and the 1 Inch Sheet number must be quoted, e.g. 84 $\frac{A}{5}$

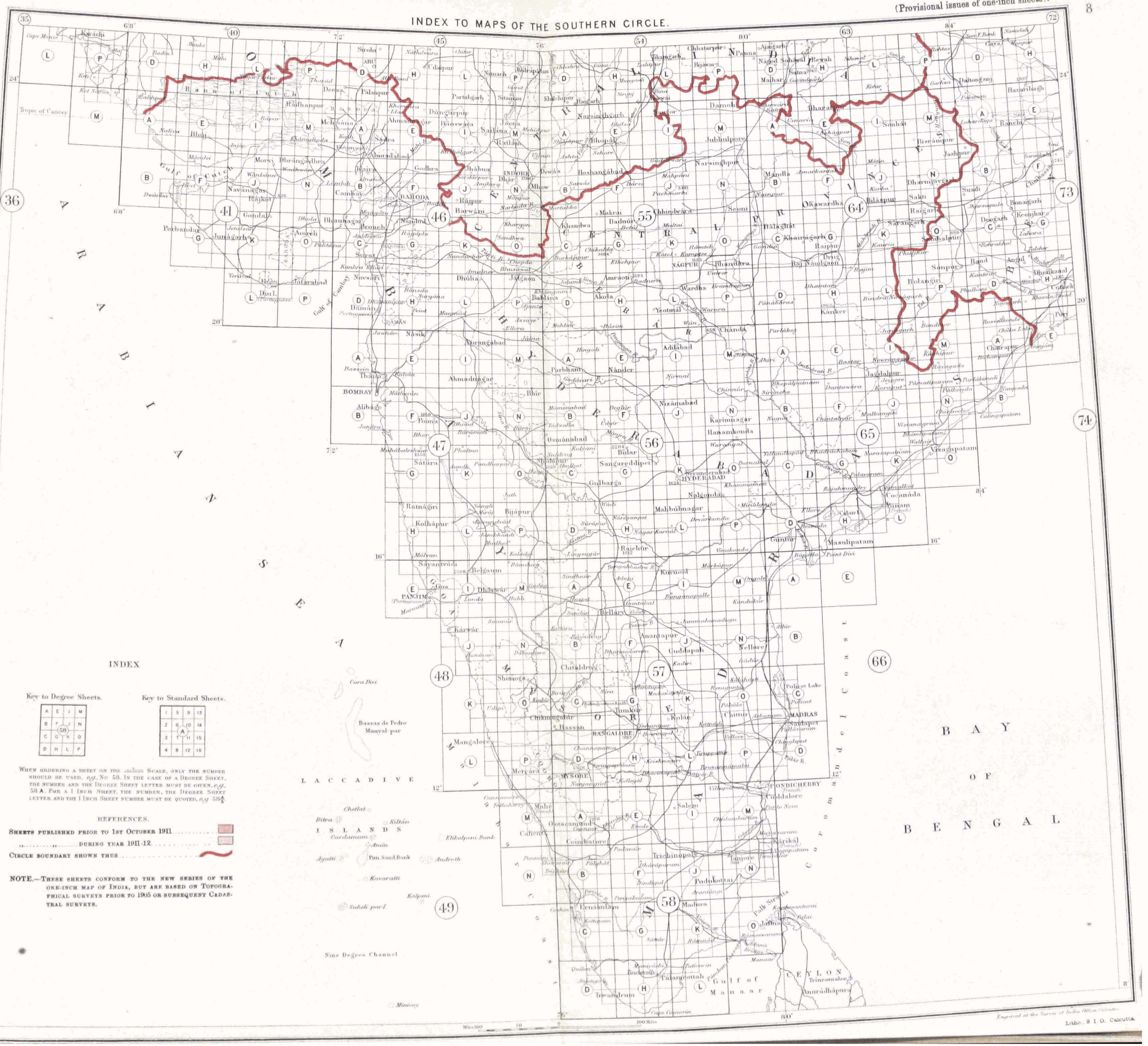
Reg. No. 2175 D., 12. 1100.
Engraved at the Survey of India Office, Calcutta.
Litho., S. I. O., Calcutta.



Reg No. 2179D., 12.—1100.

Litho., S I O. Calcutta

INDEX TO MAPS OF THE SOUTHERN CIRCLE.



INDEX

Key to Degree Sheets.

A	E	I	M
B	F	J	N
C	G	K	O
D	H	L	P

(58)

Key to Standard Sheets.

1	5	9	13
2	6	10	14
3	7	11	15
4	8	12	16

(A)

When ordering a sheet on the ~~inches~~ Scale, only the number should be used, *e.g.* No. 58. In the case of a Degree Sheet, the number and the Degree Sheet letter must be given, *e.g.* 58 A. For a 1 Inch Sheet, the number, the Degree Sheet letter and the 1 Inch Sheet number must be quoted, *e.g.* $58\frac{A}{5}$

REFERENCES.

Sheets published prior to 1st October 1911 .....

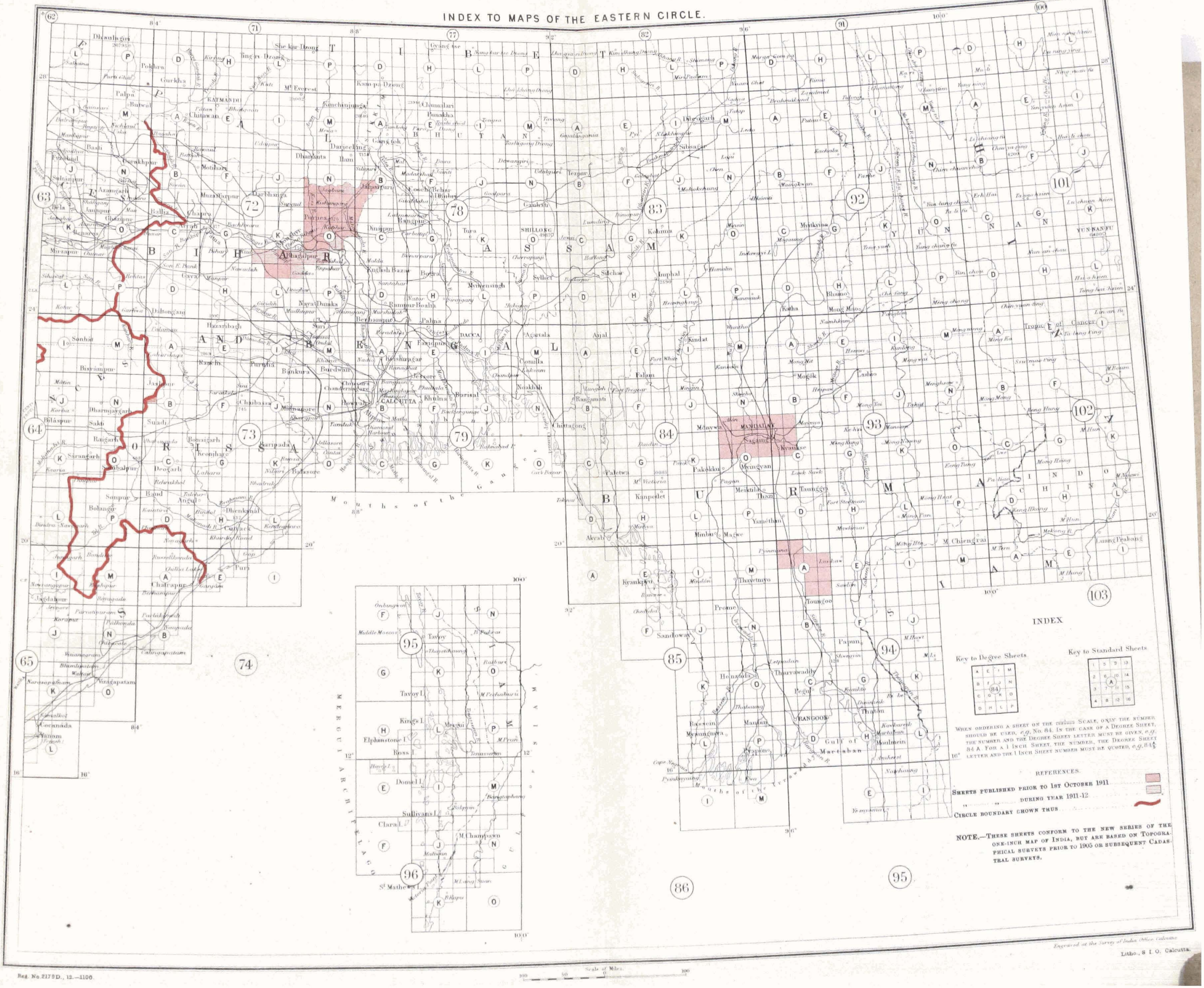
" " during year 1911-12 .....

Circle boundary shown thus .....

NOTE.—These sheets conform to the new series of the one-inch map of India, but are based on Topographical surveys prior to 1905 or subsequent Cadastral surveys.

Engraved at the Survey of India Office, Calcutta.
Litho.: S. I. O. Calcutta.

INDEX TO MAPS OF THE EASTERN CIRCLE.



INDEX TO THE DEGREE SHEETS OF INDIA.

{ On the Scale of 1 Inch to 4 Miles. }

Key to Degree Sheets.

A	E	I	M
B	F	J	N
C	G	K	O
D	H	L	P

The numbers of the sheets of the 1:1,000,000 series are shewn thus 55

REFERENCES

Degree sheets from old material published prior to Sept. 30, 1911 ...
" " " during current year ...
" from new material published prior to Sept. 30, 1911 ...
" " " during current year ...

Reg. No. 2161 D., 12.—1,200

Published under the direction of Colonel S. G. Burrard, R.E., F.R.S., *Officiating Surveyor General of India.*

1911.

Litho., S. I. O., Calcutta.

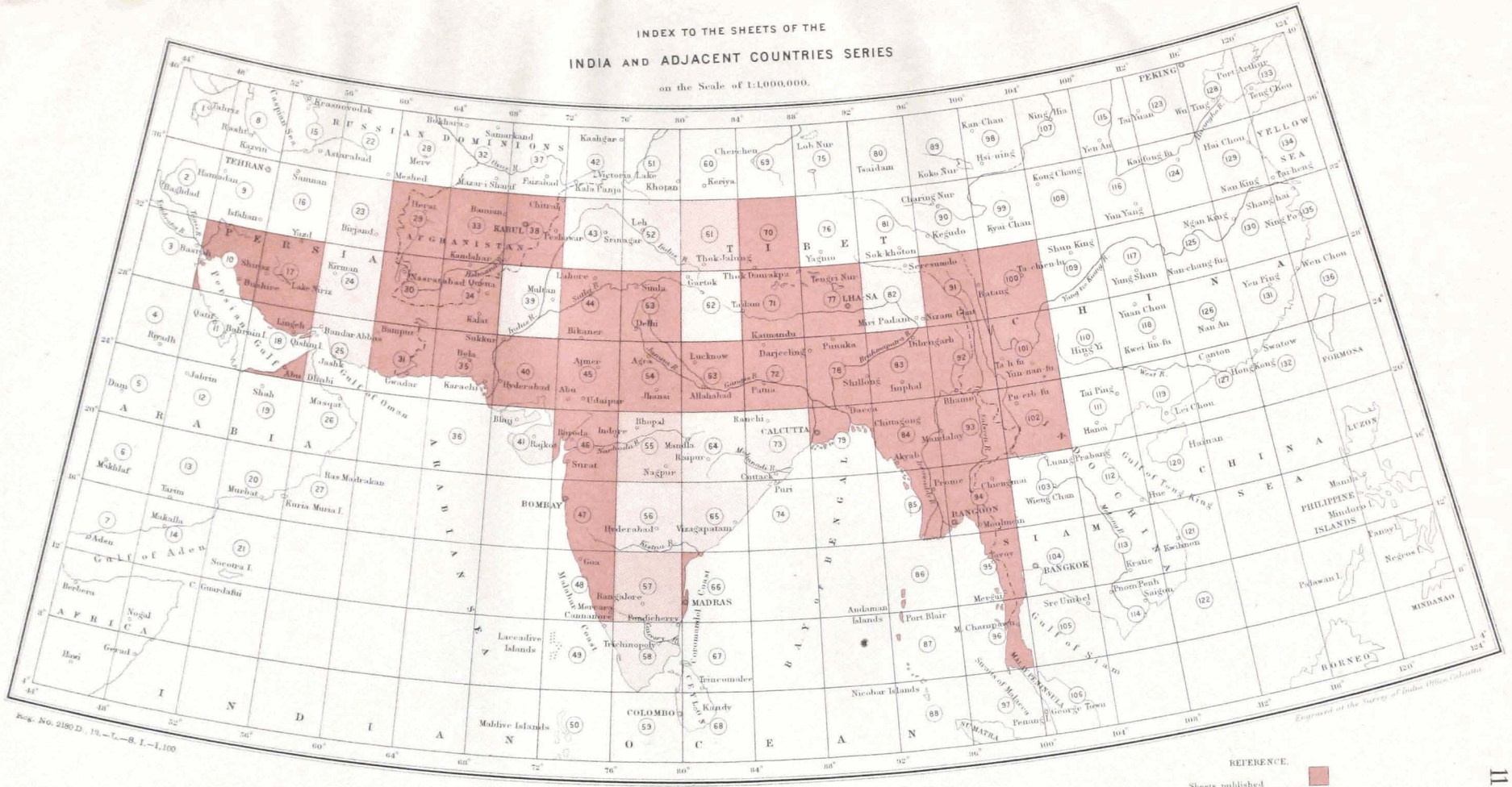
Note. The Longitudes refer to the Greenwich Meridian.

Scale 1 Inch=192 Miles or 1/12,000,000

INDEX TO THE SHEETS OF THE

INDIA AND ADJACENT COUNTRIES SERIES

on the Scale of 1:1,000,000.



Reg. No. 2180 D. 19.—7.—8. 1.—1,100

Published under the direction of The Hon'ble Colonel F. B. Longe, R.E., A.D.C., *Surveyor General of India.*

1910.

Scale 50,000,000.

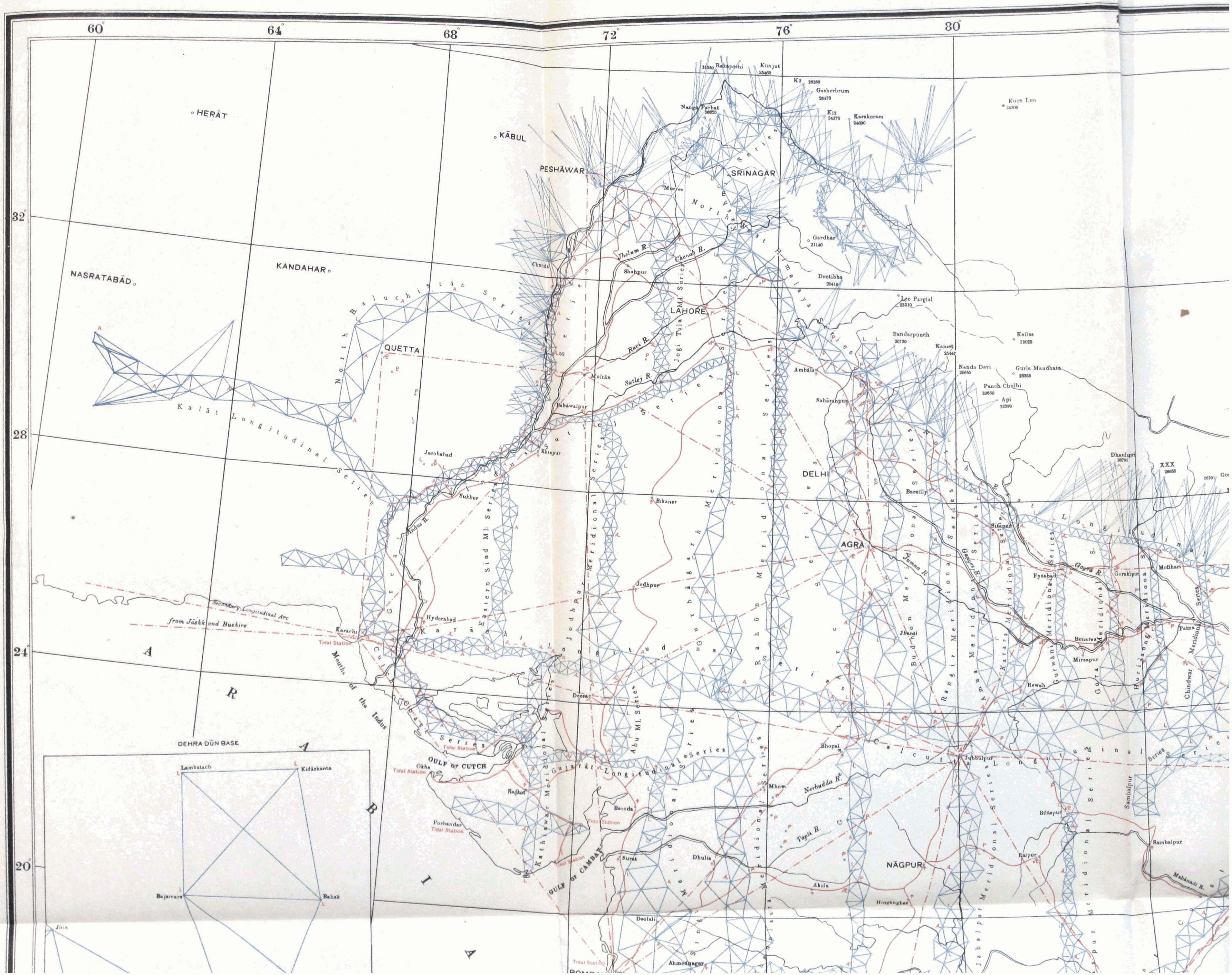
Miles 200 0 200 400 600 800 Miles.

REFERENCE.

Sheets published

" under publication

" in hand



60°
64°
68°
72°
76°
80°
32°
28°
24°
20°
HERĀT
KĀBUL
PESHĀWAR
SRINAGAR
NASRATABĀD
KANDAHAR
QUETTA
LAHORE
DELHI
AGRA
NĀGPUR
Rakaposhi
Kunjut
K2
Gasherbrum
Nanga Parbat
K12
Karakoram
Kuen Lun
Murree
Gardhar
Deotibba
Leo Pargial
Bandarpunch
Kamet
Kailas
Nanda Devi
Gurla Mandhata
Panch Chulhi
Api
Dhaulagiri
XXX
Jhelum R.
Chenab R.
Ravi R.
Sutlej R.
Shahpur
Multān
Bahāwalpur
Ambāla
Sahāranpur
Bareilly
Sitapur
Fyzabad
Gogra R.
Gorakhpur
Motihari
Patna
Benares
Mirzapur
Rewah
Jhansi
Jumna R.
Jubbulpur
Bhopal
Mhow
Nerbudda R.
Tapti R.
Bilāspur
Raipur
Sambalpur
Mahānadi R.
Akola
Hinganghat
Dhulia
Surat
Baroda
Deolali
Ahmednagar
Jacobabad
Khanpur
Sukkur
Indus R.
Hyderabad
Karachi
Tidal Station
Jodhpur
Bikaner
Deesa
Rajkot
Porbandar
Okha
GULF OF CUTCH
GULF OF CAMBAY
Mouth of the Indus
North Balūchistān Series
Kalāt Longitudinal Series
North-West Himalaya Series
North East Longitudinal Series
Great Indus Series
Kathiawar Meridional Series
Gujarāt Longitudinal Series
Abu Ml. Series
Jodhpur Meridional Series
Eastern Sind Ml. Series
Gurhāgarh Meridional Series
Rahūn Meridional Series
Budhon Meridional Series
Rangir Meridional Series
Jamua Meridional Series
Karara Meridional Series
Gurwani Meridional Series
Gora Meridional Series
Hurilaong Meridional Series
Chindwar Meridional Series
Jabalpur Meridional Series
Calcutta Longitudinal Series
Secondary Longitudinal Arc from Jāshk and Bushire
A R A B I A
DEHRA DŪN BASE
Lambatach
Kidārkānta
Bajawara
Bahak

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

DURING THE SURVEY YEAR

1911-12.

PREPARED UNDER THE DIRECTION OF

COLONEL S. G. BURRARD, C.S.I., R.E., F.R.S.,

SURVEYOR GENERAL OF INDIA.

Printed at the Photo.-Litho. Office, Survey of India,

CALCUTTA,

1913.

Price Two Rupees or Three Shillings.